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Name Of Dam: UPPER BLACKWATER NO. 4
Location: FRANKLIN COUNTY, VIRGINIA
Inventory Number: 06702

411 030

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
NORFOLK DISTRICT CORPS OF ENGINEERS
803 FRONT STREET
NORFOLK, VIRGINIA 23510

AUGUST 1979

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20. Abstract

Pursuant to Public Law 92-367, Phase I Inspection Reports are prepared under guidance contained in the recommended guidelines for safety inspection of dams, published by the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general conditions of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

Based upon the field conditions at the time of the field inspection and all available engineering data, the Phase I report addresses the hydraulic, hydrologic, geologic, geotechnic, and structural aspects of the dam. The engineering techniques employed give a reasonably accurate assessment of the conditions of the dam. It should be realized that certain engineering aspects cannot be fully analyzed during a Phase I inspection. Assessment and remedial measures in the report include the requirements of additional indepth study when necessary.

Phase I reports include project information of the dam and appurtenances, all existing engineering data, operational procedures, hydraulic/hydrologic data of the watershed, dam stability, visual inspection report and an assessment including required remedial measures.

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the design flood should not be interpreted as necessarily posing a highly inadequate condition. The design flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

BRIEF ASSESSMENT

Name of Dam:	Upper Blackwater River No. 4
State:	Virginia
County:	Franklin
USGS Quad Sheet:	Callaway
Stream:	Tributary of the North Fork of the Blackwater River
Date of Inspection:	17 May 1979

Upper Blackwater River Dam No. 4 is a zoned earthfill structure about 540 feet long and 52 feet high. The dam is owned by Mr. C. I. Dillon and maintained by the Blue Ridge Soil and Water Conservation District. The dam serves as a flood control structure and is classified as an intermediate size and significant hazard classification. The principal spillway consists of a 24-inch concrete pipe served by a drop inlet. The emergency spillway is an open channel earthen spillway. The dam is located 0.3 mile upstream of Dillons Mill, Virginia, on a tributary of the North Fork of the Blackwater River.

The emergency spillway will pass 20 percent of the Probable Maximum Flood (PMF) without overtopping the dam. Based on criteria established by the Department of the Army, Office of the Chief of Engineers (OCE), the Spillway Design Flood (SDF) is the 1/2 PMF. Since the spillway can not pass the SDF, it is rated as inadequate.

Stability conditions are satisfactory and conventional safety margins exist if the dam was constructed as specified in the design report.

The visual inspection revealed one immediate need for evaluation. The berm at the right abutment forming the left side slope of the emergency spillway should be enlarged or the side slope be protected. The corrective measure should be initiated within six months.

It is recommended that the annual inspection and maintenance program be expanded to include the suggestions listed in Section 7.2.

SUBMITTED BY: ORIGINAL SIGNED BY:
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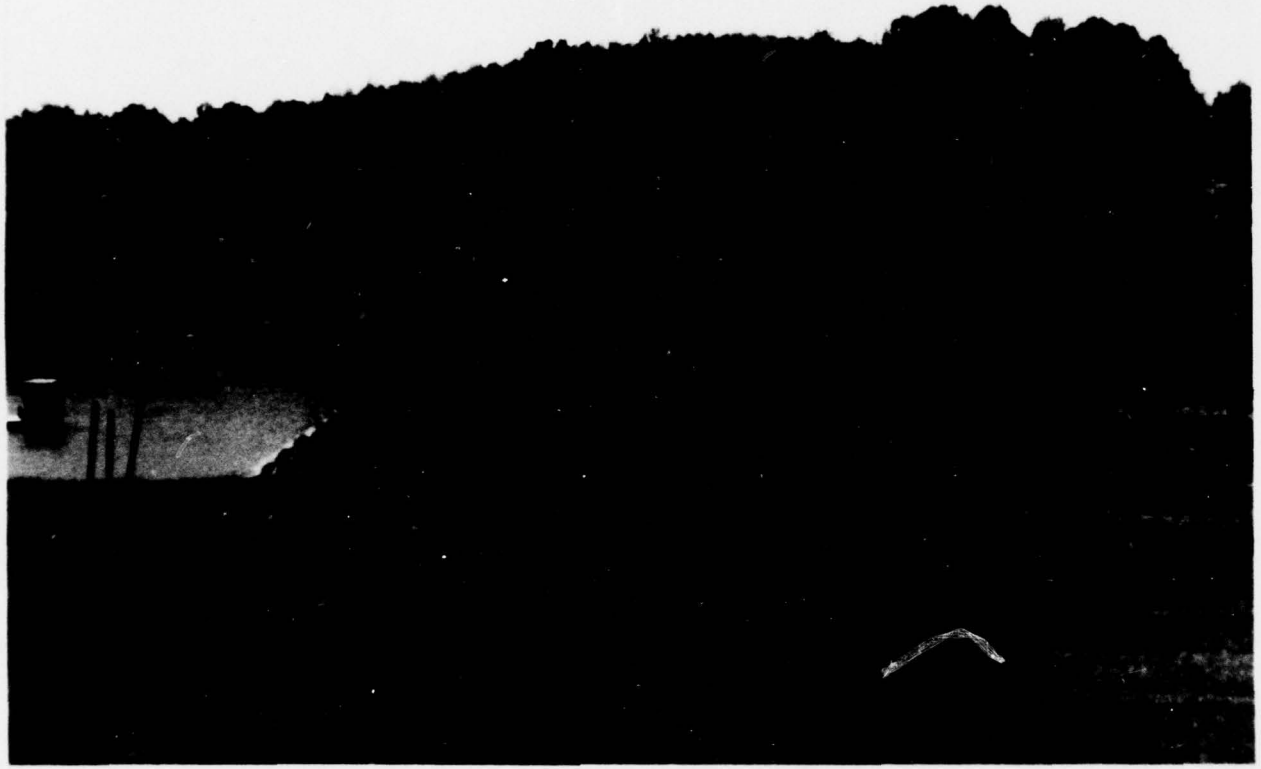
Colonel, Corps of Engineers
District Engineer

DATE: AUG 14 1979



OVERALL VIEW OF DAM

17 MAY 1979

SECTION 1

PROJECT INFORMATION

1.1 General

1.1.1 Authority: Public Law 92-367, 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers to initiate a national program of safety inspections of dams throughout the United States. The Norfolk District has been assigned the responsibility of supervising the inspection of dams in the Commonwealth of Virginia.

1.1.2 Purpose of Inspection: The purpose is to conduct a Phase I inspection according to the Recommended Guidelines for Safety Inspection of Dams (Appendix VI, Reference 1). The main responsibility is to expeditiously identify those dams which may be a potential hazard to human life or property.

1.2 Project Description

1.2.1 Dam and Appurtenances: Upper Blackwater Dam No. 4 is an earthfill structure about 540 feet long and 52* feet high. The top of the dam is 14 feet wide and is at elevation 1298.0 feet mean sea level (m.s.l.). Side slopes are 2.5 horizontal to 1 vertical (2.5:1).

The principal spillway consists of a 24-inch diameter reinforced concrete pipe, running through the dam at a low level. This pipe is served by a drop-inlet structure (riser) located in a low elevation of the reservoir just upstream from the toe of the embankment. The crest

* Height measured from streambed elevation at the downstream toe of the dam to the top of the dam.

of the riser is at elevation 1282.4. An 18-inch square low stage (secondary) inlet, with invert at elevation 1273.7, located in the riser, maintains the normal pool.

The emergency spillway is a vegetated earth-side-channel spillway located off the right end of the dam. It has a bottom width of about 100-feet with a crest at elevation 1294.1 and side slopes of 3 horizontal to 1 vertical.

A 24-inch round corrugated metal pipe with invert at a low level (elevation 1252.4) enters the upstream side of the riser from the reservoir. This permits withdrawal of water from the bottom of the reservoir.

1.2.2 Location: Upper Blackwater Dam No. 4 is located on a tributary of the North Fork of the Blackwater River. It is located about 0.3 mile upstream from Dillons Mill.

1.2.3 Size Classification: The dam is classified as an "intermediate" size structure because of its height (52 feet).

1.2.4 Hazard Classification: The dam is located in a rural area upstream of 3 to 4 homes located in the flood plain and is therefore given a significant hazard classification in accordance with guidelines contained in Section 2.1.2 of Reference 1, Appendix VI. The hazard classification used to categorize dams is a function of location only and has nothing to do with its stability or probability of failure.

1.2.5 Ownership: Mr. C. I. Dillon

1.2.6 Purpose: Flood control

1.2.7 Design and Construction History: The dam was designed and constructed under the supervision of the U.S. Soil Conservation Service. Construction was completed in July 1974 by Cardinal Construction Company.

1.2.8 Normal Operational Procedures: Operation of the project is automatic. The principal spillway is ungated; therefore water rising above the crest of the low stage (secondary) inlet is automatically passed downstream. Similarly water is automatically passed through the principal spillway crest and the emergency spillway in the event of an extreme flood which fills the flood storage space.

1.3 Pertinent Data

1.3.1 Drainage Areas: The dam controls a drainage area of 1.88 square miles.

1.3.2 Discharge at Damsite

Maximum flood at damsite not known.

Principal Spillway:

Pool level at top of dam . . . . . 78 c.f.s.

Emergency Spillway:

Pool level at top of dam . . . . . 2110 c.f.s.

1.3.3 Dam and Reservoir Data: Pertinent data on the dam and reservoir are shown in the following table:

Table 1.1 DAM AND RESERVOIR DATA

Item	Elevation feet m.s.l.	Reservoir			
		Area, acres	Capacity		Length miles
			Acre, feet	Watershed, inches	
Top of dam	1298.0	30	338	3.4	0.4
Emergency spillway crest	1294.1	26	225	2.2	0.3
Principal spillway crest	1282.4	16	177	1.8	0.2
(Secondary level orifice invert (normal pool))	1273.7	9	65	0.6	0.2
Streambed at downstream toe of dam	1246±	-	-	-	-

SECTION 2

ENGINEERING DATA

2.1 Design: The dam was designed and constructed under the direction of the U.S. Soil Conservation Service (SCS). The design data and as-built drawings are available in the office of the State Conservationist, U.S. Soil Conservation Service, P.O. Box 10026, Richmond, VA 23240.

Geologic investigation was conducted at the damsite by SCS during the initial design stages. The investigation consisted of excavating and examining in 36 test pits along the proposed centerlines of the dam, principal spillway, and emergency spillway. The test pits were excavated with a backhoe to bedrock, which was about 4 to 12 feet below ground surface. Disturbed soil samples of all significantly different materials were collected for soil testing. A 1-gallon undisturbed sample was taken from the depth of 2 to 2.75 feet along the principal spillway centerline. The test pit locations and logs are shown in Plates I, VI, and VII, Appendix I, the geologic report are inclosed as Appendix IV and the embankment design data is inclosed as Appendix V.

Referring to Plate III, the dam is a zoned earth embankment. The design specified MH and CL materials for building the zone 1 (inner core) and less impervious materials consisting mostly of ML soils for building the zone 2 (outer shell). A cutoff trench with a bottom width of 12 feet was backfilled with CL material and was constructed along the centerline of the dam with depths extending to sound bedrock (granite). The dam is founded on alluvial soils below which is bedrock.

To lower the phreatic surface at the downstream slope and to collect seepages, an internal draining system is located under the downstream portion of the dam as shown in Plate V, Appendix I. The drainage system consists of a 6-inch diameter perforated pipe embedded in a trench 4 feet wide with variable depths and filled with graded filter materials. Two interceptive drains of similar construction connect the seepage drain and run parallel to the principal spillway discharging into the stilling basin. Ten anti-seep collars were built around the principal spillway under the upstream and center portion of the dam to control the problem of piping.

Referring to Appendix V, soils samples were tested for classification and compaction properties. A consolidation test was made on each of the MH and CL residual materials. A consolidated undrained triaxial test with pore pressure measurement was made on each of the ML, MH, and CL residual materials. Test specimens of disturbed soil samples for the consolidation and strength tests were compacted to 95 percent of the standard Proctor density. The test results and interpretations are summarized as follows:

Foundation Materials (from consolidated undrained test of undisturbed sample):

Type of material	:	ML
Liquid limit	:	27 percent
Plastic index	:	4 percent
Dry density	:	93-96 p.c.f.
Water content:	:	28.3-30.0 percent
Degree of saturation	:	95.1-99.6 percent
Angle of internal friction:		16°
Cohesion	:	700 p.s.f.

Embankment Materials

1. Soil Classification and Compaction Test

	Type of Material		
	MH	ML	CL
Liquid limit, percent	53	28 - 34	30 - 38
Plastic Index, percent	9	0	11 - 15
Maximum dry density, p.c.f.	87.0	95.0-109.5	100.5-110.5
Optimum water content, percent	31.5	18.5- 23.5	16.5- 22.5

Consolidated Undrained Test

	Type of Material		
	MH	ML	CL
Dry density, p.c.f.	82.6 -83.3	96.8 -97.3	99.7 - 100.1
Pore pressure parameter B (dimensionless)	0.95-0.98	0.95- 0.98	0.95- 0.98
Total strength parameters			
Angle of internal friction, degrees	6.5	20.5	10
Cohesion, p.s.f.	1200	800	475
Effective strength parameters			
Angle of internal friction	11.0	31.0	27.5
Cohesion, p.s.f.	1200	500	200

The stability of the embankment was checked with circular failure surface using a computer and SCS program, but the method of analysis is not given. The stability of the embankment was also checked with the sliding wedge method used by Navdocks. Dimensions of the embankment used in the analysis are given in Appendix V. The embankment is

assumed to be founded on 2 feet thick layer of ML material which overlies another 2 feet of SM material. The stability analyses were made with a combination of strength parameters that would result in the least shear strength for the loading range planned, although this could not be verified. All the analyses were made with the total strength parameters of the CL material for zone 1 (inner core) and the effective strength parameters of the ML material for zone 2 (shell). Since no shear strength test was made on the SM material in the foundation, the effective strength parameters were assumed. Pertinent soils data for the analysis are summarized as follows:

Section:	Embankment		Foundation	
Material:	CL	ML	ML	SM
Dry density, p.c.f.	99.9	97.2	94.4	-
Wet density, p.c.f.	117.5	115.0	-	-
Saturated density, p.c.f.	135.5	123.0	122.0	-
Total strength parameter				
$\emptyset$, degree	10.0	-	16.0	-
c, p.s.f.	475	-	700	-
Effective strength parameter				
$\bar{\emptyset}$, degree	-	31	-	35
$\bar{c}$, p.s.f.	-	500	-	0

The safety factor for the upstream slope under full drawdown condition (with pool level at the emergency spillway crest, elevation 1291.5) is 1.39 governed by the sliding wedge method. The safety factor for the downstream slope under steady seepage (with pool level at the emergency spillway crest, and internal drain at c/b = 0.6) is 1.54 governed by the circular arc method. Calculations for the analysis are not available. The safety factors for the loading conditions satisfy the suggested values given in Reference 1, Appendix VI.

No information on settlement and seepage analysis was available. An overfill of 1.25 feet was recommended to compensate for consolidation of the compacted fill and the foundation. The design specified a minimum placement density of 95 percent of standard Proctor density and a placement moisture content slightly wet of optimum.

The emergency spillway is constructed by a cut in residual soils. The design specified a 100-foot bottom width, 3:1 side slopes, 2 percent entrance slope, 4 percent exit slope and a 30-foot control section. The bottom of the spillway was undercut 1-foot and refilled with compacted fill. The spillway is separated from the dam by a very narrow berm (see Plate I, Appendix I).

2.2 Construction: The construction records were not furnished by the SCS office in Richmond, but they are available from the SCS office in Washington, D.C.

2.3 Evaluation: The Design Report and the as-built drawings provided by SCS were adequate for review. Although no construction records were available, the general shape of the embankment appeared to be in accordance with the as-built drawings which were available during the inspection.

SECTION 3

VISUAL INSPECTION

3.1 Findings:

3.1.1 General: The inspection was made on May 17,1979 during a normal period which was not preceded by a long period of rainfall nor a draught. The weather was clear and dry. The ground surfaces at the embankment were firm and dry except at a wet area at the toe of the downstream slope just to the left of the outlet pipe. Information observed in the field is given in Appendix III.

3.1.2 Embankment: All faces of the embankment were moderately covered with grasses about 8 inches tall. There were many bare spots. The ground surfaces were firm and dry except for a wet area at the downstream toe. The faces of the embankment were smooth which indicated that there were no apparent settlement or instability problems. It appeared that the internal drainage system for the embankment is working properly, as the water discharging from the two 6-inch drains (less than 1 GPM) was clear, indicating no sign of internal erosion. At normal pool, no erosion was noted at the upstream slope shoreline although no ripraps was used to protect the shoreline. A small shrub had grown on the upstream slope. Some slope sloughing was noted at the toe of the downstream slope just to the right of the outlet pipe. To the left of the outlet pipe, an area of about 50 feet square adjacent to the toe was covered with 2 to 6 inches of water, but no flowing water was observed. The whole wet area was covered with marsh grass. The ground at the toe above the wet area was also very soggy. Approximately 100 feet further downstream from the wet area, another large wet area (200 feet square) was covered with similar type of marsh grass. The ground joining the two marshy areas was soggy. Further discussion of these two areas is given in Section 3.1.6.

3.1.3 Junction of Embankment and Abutment: At the left junction, animal burrows as large as 12 inches in diameter were observed on both the upstream and downstream slopes. Soils at the lower section of the left junction were eroded and gullies formed up to 18 inches deep.

3.1.4 Appurtenant Structures: The intake structure was not inspected because the structure is only accessible by boat. Observing from a distance, the concrete structure appeared to be in excellent condition. Water was discharging through the 24-inch-diameter outlet pipe about 1/6 full. The outlet pipe and its concrete saddle were in excellent condition. The handle for the emergency gate located at the intake structure was not in place; it is stored at the landowner's premises.

3.1.5 Emergency Spillway: All faces of the spillway were covered with short grasses, except the left side slope of the approach channel where the entire slope was bare. It was placed too closely to the right abutment so that the natural berm which forms the left side slope of the approach channel was very narrow. Should the emergency spillway operate, the narrow berm could be eroded to the extent that the dam might breach at the right abutment.

3.1.6 Stilling Basin and Downstream Channel: The stilling basin extends approximately 30 feet from the toe of dam at the outlet pipe. The banks were protected with riprap from 4 to 18-inches in size. The riprap surface appeared to be relatively even indicating that the rocks had been placed properly. Some small trees and shrubs are growing in the riprap. Water flows freely from the basin into the downstream channel which is about 4 feet wide. Both the stilling basin and the downstream channel are in good condition. About 100 feet downstream from the outlet pipe, water is flowing at a rate of 10 GPM from a 12 inch diameter hole on the left bank of the downstream channel.

It could not be determined whether the flow was from a natural spring, which also caused the wet marshy areas discussed in section 3.1.2, during the visual inspection. Four drainage pipes were found on the left bank of the downstream channel. Although all the pipes were dry, it appeared to be an attempt, as related by the landowner, to drain the marshy areas which existed prior to the dam construction. Two subterranean flows were observed in the channel which discharges into the Blackwater River.

3.1.7 Reservoir Area: The slopes of the reservoir bank were gentle. Minor erosion was noted around the entire shoreline. About 75 percent of the surrounding land is pasture and the rest is covered with trees.

3.1.8 Downstream Area: State Highway 643 crosses the flood plain about 1,000 feet downstream of the dam. Three to four homes were located further downstream from the highway.

3.2 Evaluation: The embankment, appurtenant structures, emergency spillway, and stilling basin are in good condition. Some unfavorable conditions observed during the field inspection should be further evaluated and possibly corrected. Some of the conditions can be corrected as part of the preventive maintenance program. The recommended measures are summarized as follows:

a. The berm at the right abutment forming the left side slope of the emergency spillway should be enlarged or the side slope be protected. The left side slope of the emergency spillway was bare at the time of inspection. Since the berm was unusually narrow, a grass cover protection for the slope may not be adequate. If the berm were eroded when the emergency spillway operates, the dam could breach at the right abutment.

b. The wet area at the downstream toe and the flow of water from the hole at the downstream channel should be monitored closely (see sections 3.1.2 and 3.1.6). It could not be determined whether the wet area and this flow were due to seepage from the lake or from natural springs, which could have existed prior to the dam construction. Although the situation is not a major problem at this time, the wet area and the flow rate at the hole should be monitored closely. The flow rate should be fairly steady at normal pool condition. Any sudden change in the flow rate as well as change in water turbidity should be detected at an early stage for implementing appropriate remedial measures. The flow rate and the pool level should be recorded at the same time especially at extremely wet periods. The source of this flow and the wet area should be determined before the normal pool level is raised from the present elevation of 1273.7 feet to 1282.4 in the future.

c. All bare spots should be seeded and fertilized to form a good grass cover.

d. All gullies caused by runoff and animal burrows should be filled with compacted soils of the same type forming the face of the dam. The restored areas should be seeded to form a good grass cover.

e. Remove all trees and shrubs from the riprap at the stilling basin and from the upstream slope.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedures: Operation of the project is automatic. The 24-inch diameter principal spillway is ungated, therefore, water rising above the low level drop-inlet crest is automatically passed downstream. This in turn automatically maintains the pool level at, or near, elevation 1273.7 most of the time. Water is automatically passed through the high level drop inlet and the emergency spillway, in the event of an extreme flood which fills the flood storage space. A 24-inch sluice gate located at low level of the intake structure can be operated to dewater the reservoir.

4.2 Maintenance: Maintenance of the project consists mainly of fertilizing, liming, and mowing the embankment and emergency spillway, which is performed by the Blue Ridge Soil and Water Conservation District and dam owners.

4.3 Warning System: At the present time, there is no warning system or evacuation plan in operation.

4.4 Evaluation: The dam does not require an elaborate operational and maintenance procedure. However, the annual maintenance and inspection program should be expanded from its present form to help detect and control problems that may occur.

SECTION 5

HYDRAULIC/HYDROLOGIC DATA

5.1 Design: The dam was designed and constructed as a class b dam under the U.S. Soil Conservation Service. The design data was obtained and evaluated according to the guidelines in Reference 1, Appendix VI.

5.2 Hydrologic Records: None were available.

5.3 Flood Experience: The maximum flood is not known.

5.4 Flood Potential: The 1/2 PMF and PMF were developed and routed through the reservoir by use of the HEC-1DB computer program (Reference 2, Appendix VI) and appropriate unit hydrograph, precipitation, and storage-outflow data. Clark's Tc and R coefficients for the local drainage area were estimated from basin characteristics. The rainfall applied to the developed unit hydrograph was obtained from a U.S. Weather Bureau Publication (Reference 3, Appendix VI). Losses were estimated at an initial loss of 1.0 inch and a constant loss thereafter of 0.05 inch/hour.

5.5 Reservoir Regulation: Pertinent dam and reservoir data are shown in Table 1.1.

Regulation of flow from the reservoir is automatic. Water rising above the secondary level orific invert flows into the riser and passes through the dam in the 24-inch concrete pipe. Water also flows past the dam through the principal spillway crest and the emergency spillway in the event water in the reservoir rises to the intake crests.

The storage curve and the emergency spillway rating curve developed by the Soil Conservation Service was used in the development of this report. Rating curves were developed for the non-overflow section and the drawdown outlet. In routing hydrographs through the reservoir, it was assumed that the intial pool level was at the secondary level orifice invert. Flow through the principal spillway was neglected during routing.

5.6 Overtopping Potential: The probable rise of the reservoir and other pertinent information on reservoir performance is shown in the following table:

Table 5.1. RESERVOIR PERFORMANCE

Item	Normal flow	Hydrograph 1/2 PMF	Hydrograph PMF 1/
Peak flow c.f.s.			
Inflow	2	6883	13765
Outlow	2	6854	13733
Maximum elevation ft., m.s.l.		1299.5	1301.0
Emergency spillway (el. 1294.i)			
Depth of flow, ft.		5.4	6.9
Duration, hrs.		17	17
Velocity, f.p.s. 2/		10.5	12.1
Non-overflow section (el. 1298.0)			
Depth of flow, ft.		1.5	3.0
Duration, hrs.		2.5	4.5
Velocity, f.p.s. 2/		5.6	7.9
Tailwater elevation ft., m.s.l.	1248±	-	-

1/ The PMF is an estimate of flood discharges that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

2/ Critical velocity.

5.7 Reservoir Emptying Potential: The 24-inch pipe entering the upstream side of the riser at a low level will permit withdrawal of about 74 c.f.s. with the reservoir level at the principal spillway crest and essentially dewater the reservoir in less than 1 day.

5.8 Evaluation: Based on the size (intermediate) and hazard classification (significant) the recommended Spillway Design Flood is 1/2 PMF. Based on the risk involved in this project, it is considered that 1/2 PMF is appropriate as a Spillway Design Flood. The emergency spillway will pass 20 percent of the PMF without overtopping the dam. The 1/2 PMF will overtop the dam for a duration 2.5 hours and reach a depth of 1.5 feet over the top of the dam.

Conclusions pertain to present day conditions and the effect of future development on the hydrology has not been considered.

SECTION 6

STRUCTURAL STABILITY

6.1 Foundation and Abutments: The dam is located in the Ridge and Valley Province of Virginia. The damsite is underlain by coarse granite. The site lies across a narrow valley bottom in Precambriam gneisses near the southeast edge of the Virginia Blue Ridge complex. The coarse granite contains quartz, feldspar, mica, and hornblende. The granite, gneissic in places, is exposed in the stream bottom, downstream from the centerline of the dam and also in the left upstream portion of the foundation. Occasional vein quartz cuts the granite. From the outcrops and the blocky nature of the boulders weathered from granite, it appears that a joint system is well developed in the granite. Potential leakage could develop through the joint system.

The centerline of the dam crosses a narrow valley bottom between moderately steep abutments. Depth to rock on the left abutment varies from 4 to 8 feet. The residual soils consist of an upper layer of silt and clay classified as CL and ML, and a lower layer of hard micaceous silty sand or sandy silt classified as SM and ML. Depth to rock on the right abutment varies from 8 to 12 feet. The residual soils overlying the rock are mostly silty sand. Depth to rock in the flood plain varies from 6 to 9 feet. The lowest alluvial layer is quartz pebble and cobble gravel with a silty sand matrix classified as SM and GM material. An intermediate layer consists of sandy silt and silty sand and it is overlain by alluvial silty clay.

The dam is founded on alluvial soils which vary in thickness from 6 to 9 feet. In the stability analysis, the foundation was considered to consist of a 2-foot thick upper layer of ML soils and a 2-foot thick lower layer of SM-GM soils. A cutoff trench was constructed along the dam centerline extending along both abutments at least as far as the 100-year sediment pool at elevation 1282.4 (see Plate II, Appendix I). The base width of the trench is 12 feet and the excavation for the cutoff was specified to be into solid granite bedrock. The geologic report of the damsite is inclosed in Appendix IV. The logs of test holes are shown on Plate VI and VII, the profile along the cutoff trench is shown on Plate II, Appendix I.

6.2 Embankment: The as-built drawing (Plate III, Appendix I) indicates that the crest of the dam is 14 feet wide and contructed to elevation 1299.25. The estimated settlement of the fill was 1.25 feet so that the final elevation of the crest would be 1298.0 feet. The upstream slope is 2-1/2:1 with a 10-foot berm at elevation 1263.9, and below the berm, the slope changes to 4:1. The berm slopes downward at a 10:1 slope. The downstream slope is 2-1/2:1 with a 10-foot berm located at elevation 1272.0. The berm is horizontal.

The embankment is a two-zoned earthfill structure. The trapezoidal shaped core with 1:1 side slope is noted as zone 1 and is constructed with CL and MH materials. The shell is noted as zone 2 and is constructed with a variety of material classified as ML, SM, and GC-GM. All the materials were to be placed in a 9-inch lift at a minimum of 95 percent of standard Proctor density and with moisture content slightly wet of optimum.

6.3 Evaluation: The following evaluations are made based on visual inspection and review of existing records. The construction records and stability analysis calculations were not available. The visual inspection revealed no evidence of undue settlement, cracks, slope instability, nor improper functioning of internal drains. The cutoff trench, the anti-seep collars around the principal spillway, and the internal drains appeared to be effective in controlling to some extent the seepage during the normal pool condition at elevation 1273.7 (the 50-year sediment pool). With proper maintainance, the grass vegetative cover appeared to adequately protect the faces of the embankment. The relatively flat upstream slope of 4:1 appeared to adequately protect the shoreline from erosion caused by wave action.

The design report (see Appendix V) did not indicate that the safety factors for the stability analysis are the minimum values. Conventional analyses using a computer normally give the minimum safety factors. If this is the case, the stability conditions are satisfactory and the conventional safety margins exist (see Section 2.1).

The undesirable conditions noted are the wet area at the toe of the downstream slope, (discussed in Section 3.1.2) and the underground spring at the left bank of the downstream channel (discussed in Section 3.1.6). With only visual inspection, it could not be determined whether the wet areas and the spring were due to seepage from the reservoir or due to natural springs which existed prior to the dam construction. Due to the fact that the geology report failed to mention any springs or swamps in the site investigation and the suspected joint system in the granite (see Section 6.1 and Appendix IV), one cannot rule out that these conditions are not caused by seepage from the reservoir. Although the situation is not a major problem at this time, the wet area and the flow rate of the spring

should be closely monitored. More importantly, the source of these conditions must be determined and any remedial measures should be made before the present normal pool at elevation 1273.7 is raised to elevation 1282.4 in the future.

Although the emergency spillway is constructed by an earth cut at the right abutment, it is separated from the dam by a very narrow berm (see Plate I, Appendix I). The Design Report by SCS indicated that the location of the spillway was restricted by a cemetery. The approach left slope of the spillway was bare at the time of inspection. Since the berm is unusually narrow, a grass cover protection for the side slope may not be adequate. If the berm were eroded when the emergency spillway operates, the dam could breach at the right abutment. Proper protective cover should be constructed on the entire left side slope of the spillway.

As the dam is located in seismic zone 2, the dam may be assumed to present no hazard from earthquakes provided the stability conditions are satisfactory and conventional safety margins exist.

SECTION 7

ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Assessment: The Upper Blackwater River Dam No. 4, as observed 17 May 1979, appeared to be in good condition with the reservoir level at normal pool. Available engineering data was adequate for review. The Spillway Design Flood (1/2 PMF) will overtop the dam for a duration of 2.5 hours and reach a depth of 1.6 feet over the top of the dam. The emergency spillway will pass 20 percent of the PMF before overtopping the dam. The emergency spillway is therefore, adjudged as inadequate. The actual structure is similar to the as-built drawings given in Appendix I. The stability conditions are satisfactory and the conventional safety margins exist if the dam was constructed as specified in the design report.

The following unfavorable conditions observed should be further evaluated and possibly corrected.

a. The berm at the right abutment forming the left side slope of the emergency spillway should be enlarged or the side slope protected. This corrective measure should be initiated within six months.

b. The source of the wet condition at the toe of the dam should be determined and appropriate remedial measures be taken before the present normal pool is raised to the 100-year sediment pool.

7.2 Recommended Remedial Measures: It is recommended that the annual inspection and maintenance program be expanded to include the following:

a. Monitor the wet area at the downstream toe and the discharge from the hole on the left bank of the downstream channel about 100 feet downstream of the outlet pipe. Monitoring should also be accomplished during periods when the reservoir rises above normal pool.

b. All bare spots should be seeded and fertilized to form a good grass cover.

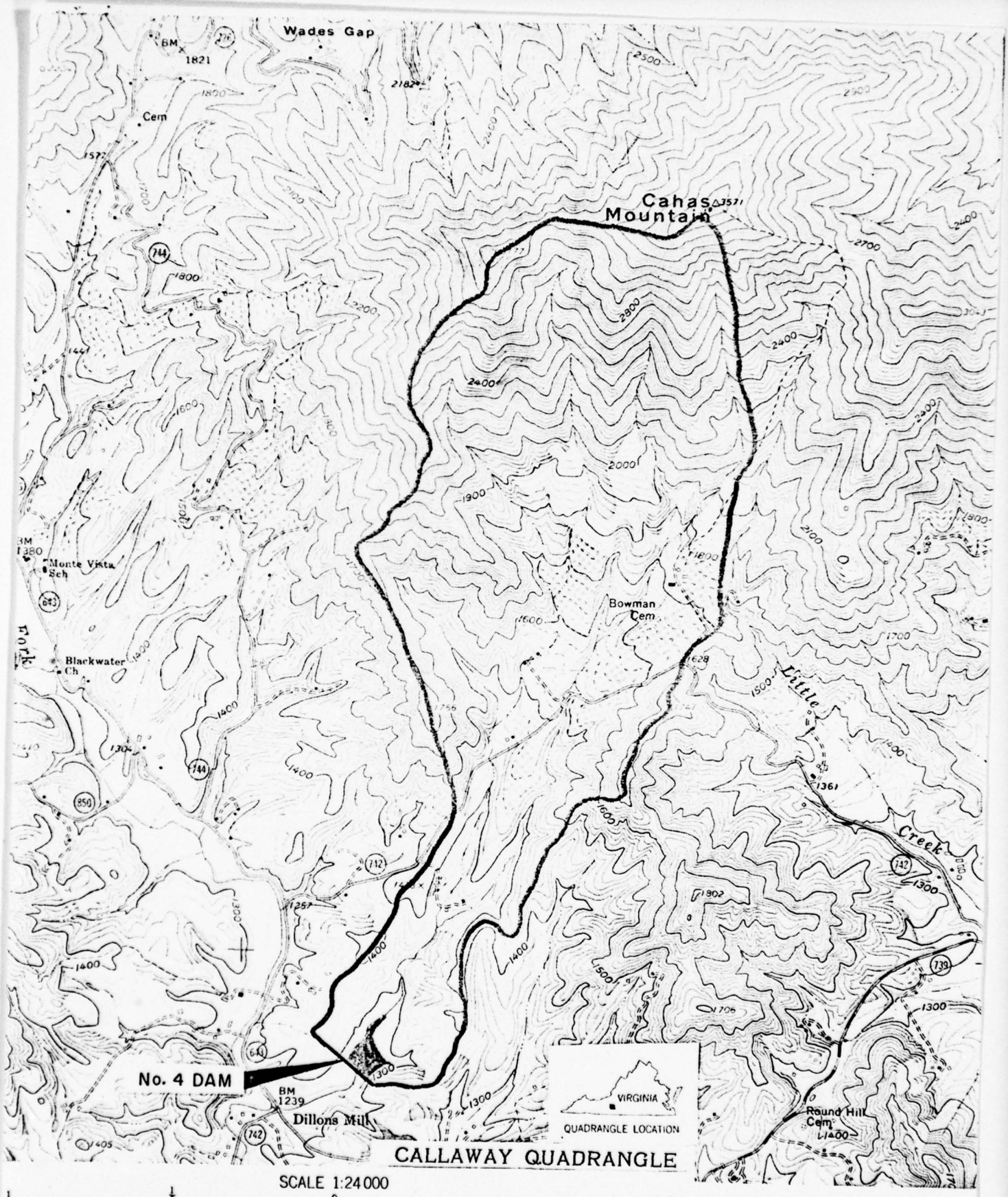
c. All gullies caused by runoff and animal burrows should be filled with compacted soils of the same type used to form the face of the dam. The restored areas should be seeded to form a good grass cover.

d. Remove all trees and shrubs from the riprap at the stilling basin and from the upstream slope.

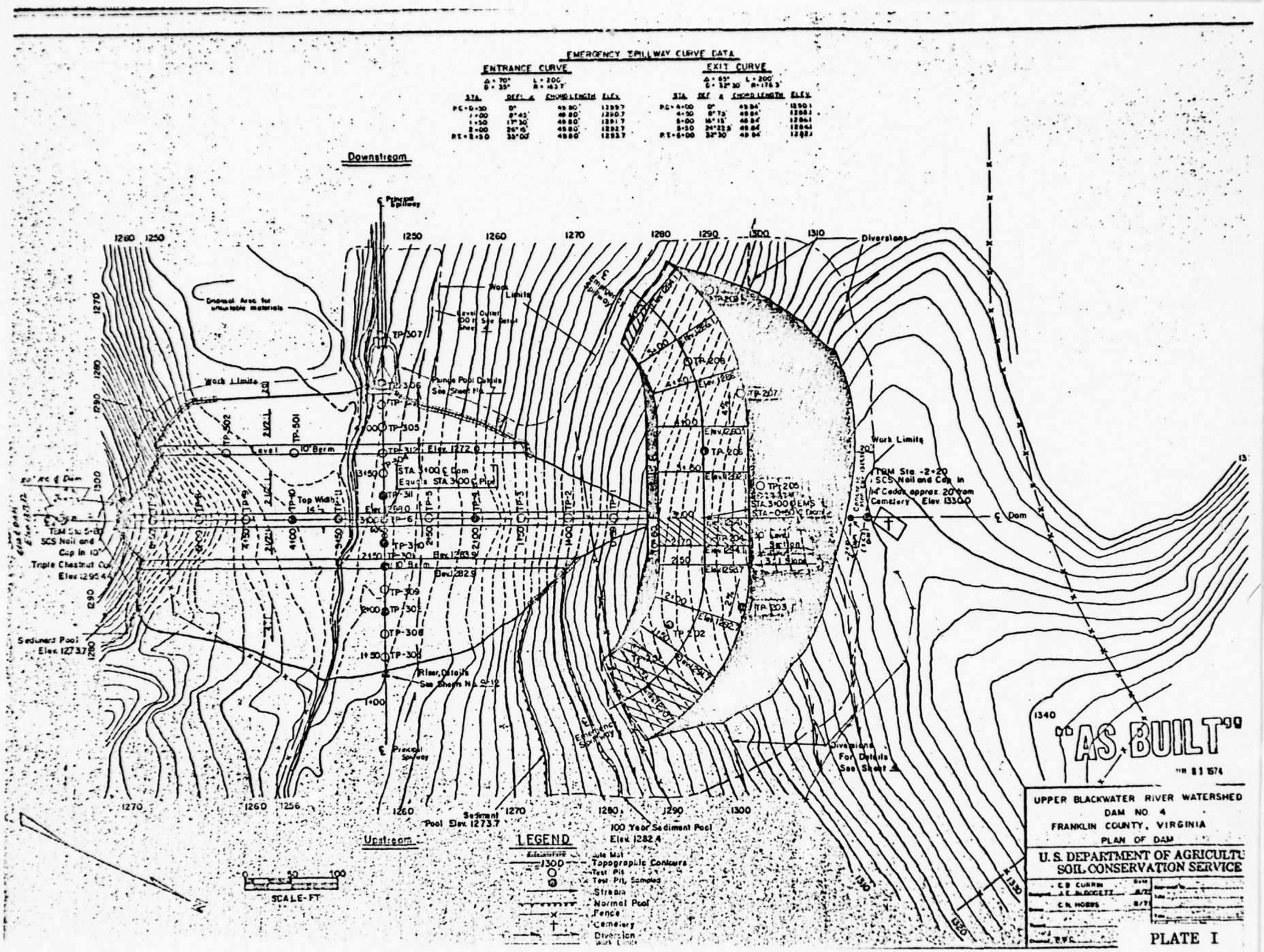
e. Install a staff gage in the reservoir.

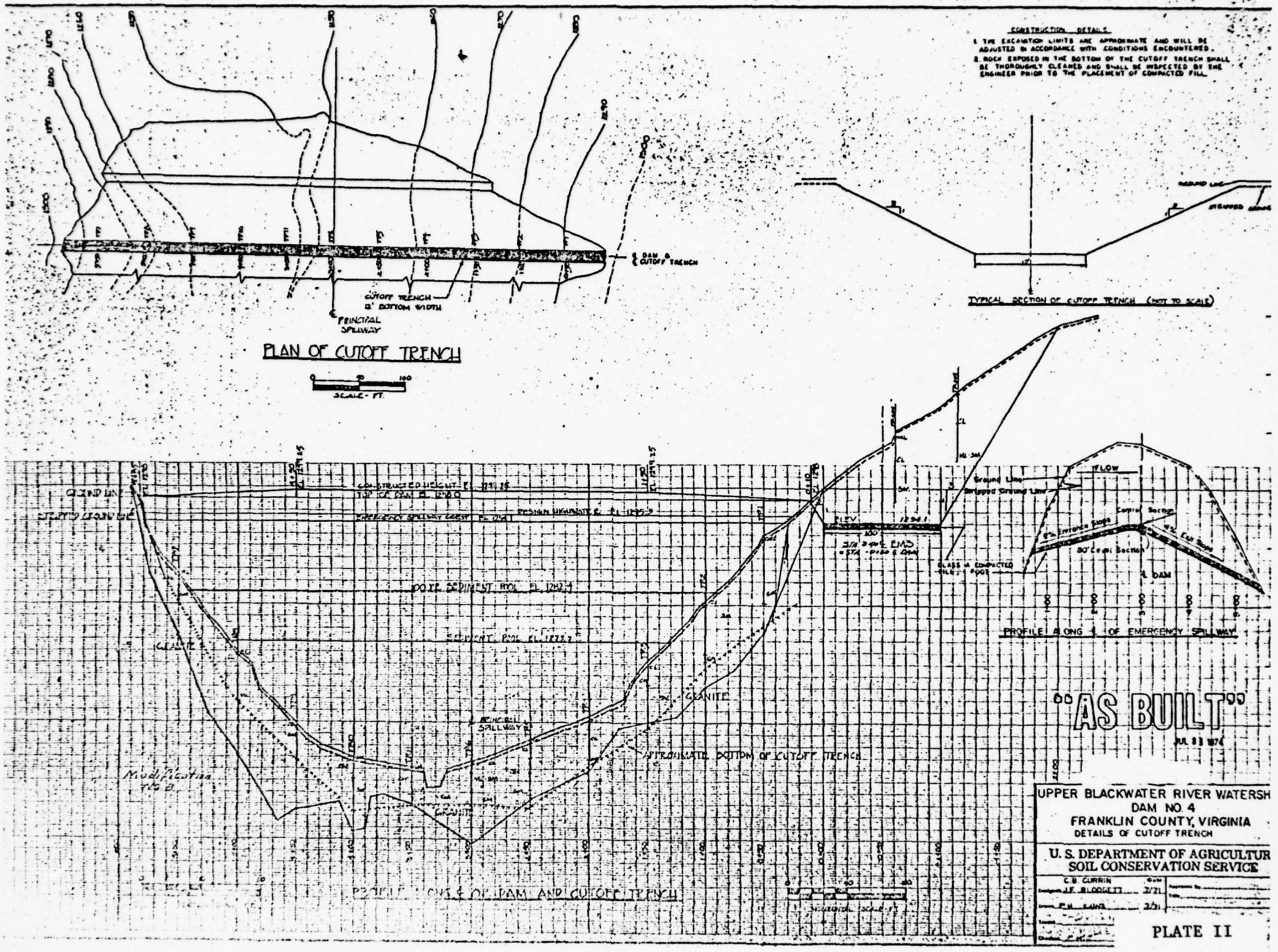
APPENDIX I

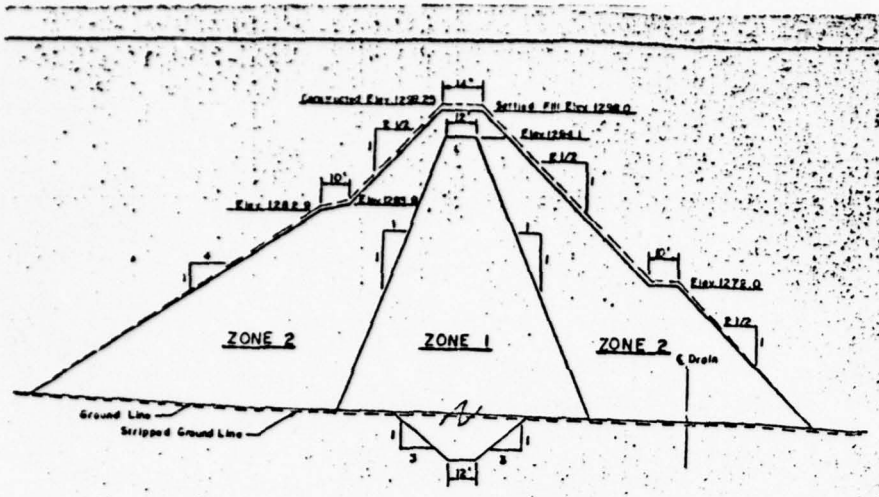
MAPS AND DRAWINGS



BLACKWATER RIVER
No. 4 DAM


EMERGENCY SPILLWAY CURVE DATA
ENTRANCE CURVE
EXIT CURVE
Downstream
Upstream
Diversions
Work Limits
Disposal Area for unsuitable materials
Pumping Pool Controls See Sheet No. 7
Top Width 14'
Sediment Pool Elev. 1273.7
100 Year Sediment Pool Elev. 1282.4
TBM Sta. 5+00 SCS Nail and Cap in 10" Triple Chestnut Oak Elev. 1295.44
TBM Sta. -2+20 SCS Nail and Cap in 14" Cedar approx. 20' from Cemetery Elev. 1330.0
Riser, Details See Sheets No. 9-12
Principal Spillway
Emergency Spillway
Dam
LEGEND
Topographic Contours
Test Pit
Test Pit, Sampled
Streams
Normal Pool
Fence
Cemetery
Diversion
SCALE-FT
"AS BUILT"
UPPER BLACKWATER RIVER WATERSHED
DAM NO. 4
FRANKLIN COUNTY, VIRGINIA
PLAN OF DAM
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
C.B. CURRIN
A.E. BLODGETT
C.N. HOBBS
PLATE I


CONSTRUCTION DETAILS
1. THE EXCAVATION LIMITS ARE APPROXIMATE AND WILL BE ADJUSTED IN ACCORDANCE WITH CONDITIONS ENCOUNTERED.
2. ROCK EXPOSED IN THE BOTTOM OF THE CUTOFF TRENCH SHALL BE THOROUGHLY CLEANED AND SHALL BE INSPECTED BY THE ENGINEER PRIOR TO THE PLACEMENT OF COMPACTED FILL.
CUTOFF TRENCH 12' BOTTOM WIDTH
PRINCIPAL SPILLWAY
PLAN OF CUTOFF TRENCH
SCALE - FT.
TYPICAL SECTION OF CUTOFF TRENCH (NOT TO SCALE)
PROFILE ALONG ℄ OF EMERGENCY SPILLWAY
"AS BUILT"
GRANITE
APPROXIMATE BOTTOM OF CUTOFF TRENCH
PROFILE ALONG ℄ OF DAM AND CUTOFF TRENCH
UPPER BLACKWATER RIVER WATERSH
DAM NO. 4
FRANKLIN COUNTY, VIRGINIA
DETAILS OF CUTOFF TRENCH
U. S. DEPARTMENT OF AGRICULTUR
SOIL CONSERVATION SERVICE
PLATE II

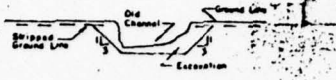


TYPICAL SECTION OF COMPACTED FILL

(NOT TO SCALE)

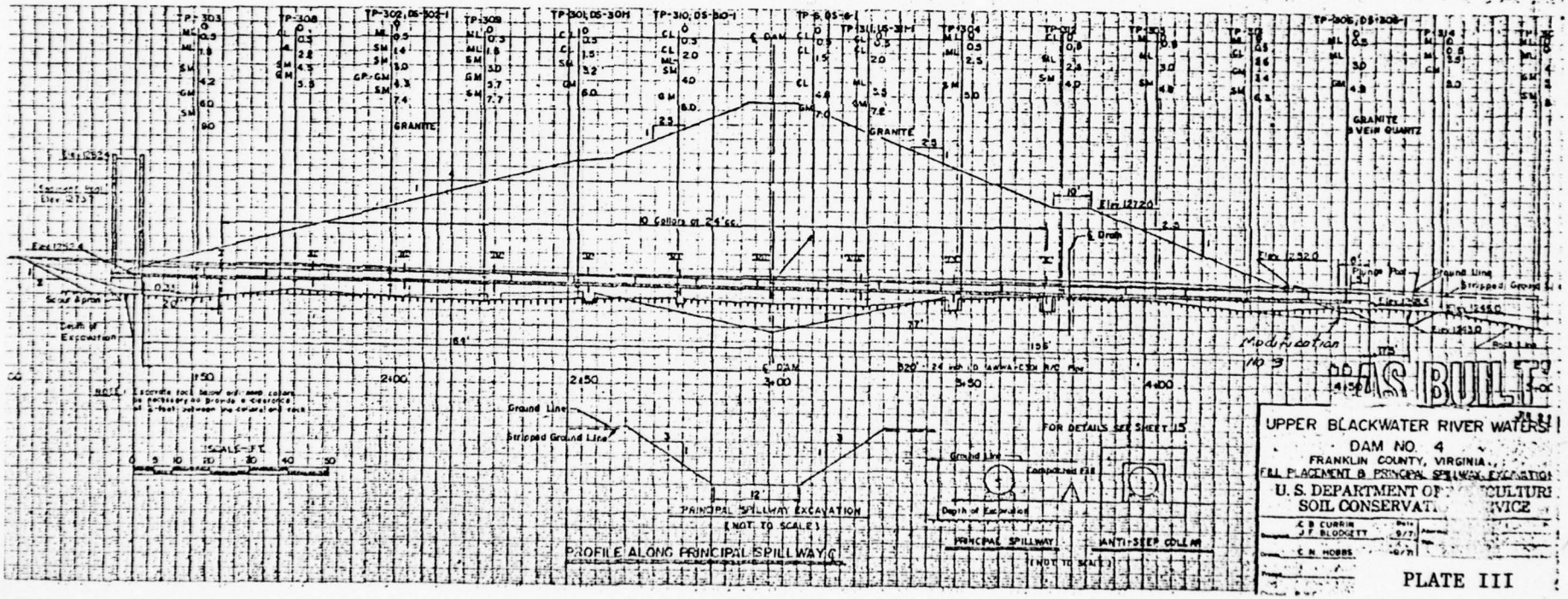
CONSTRUCTION DETAILS

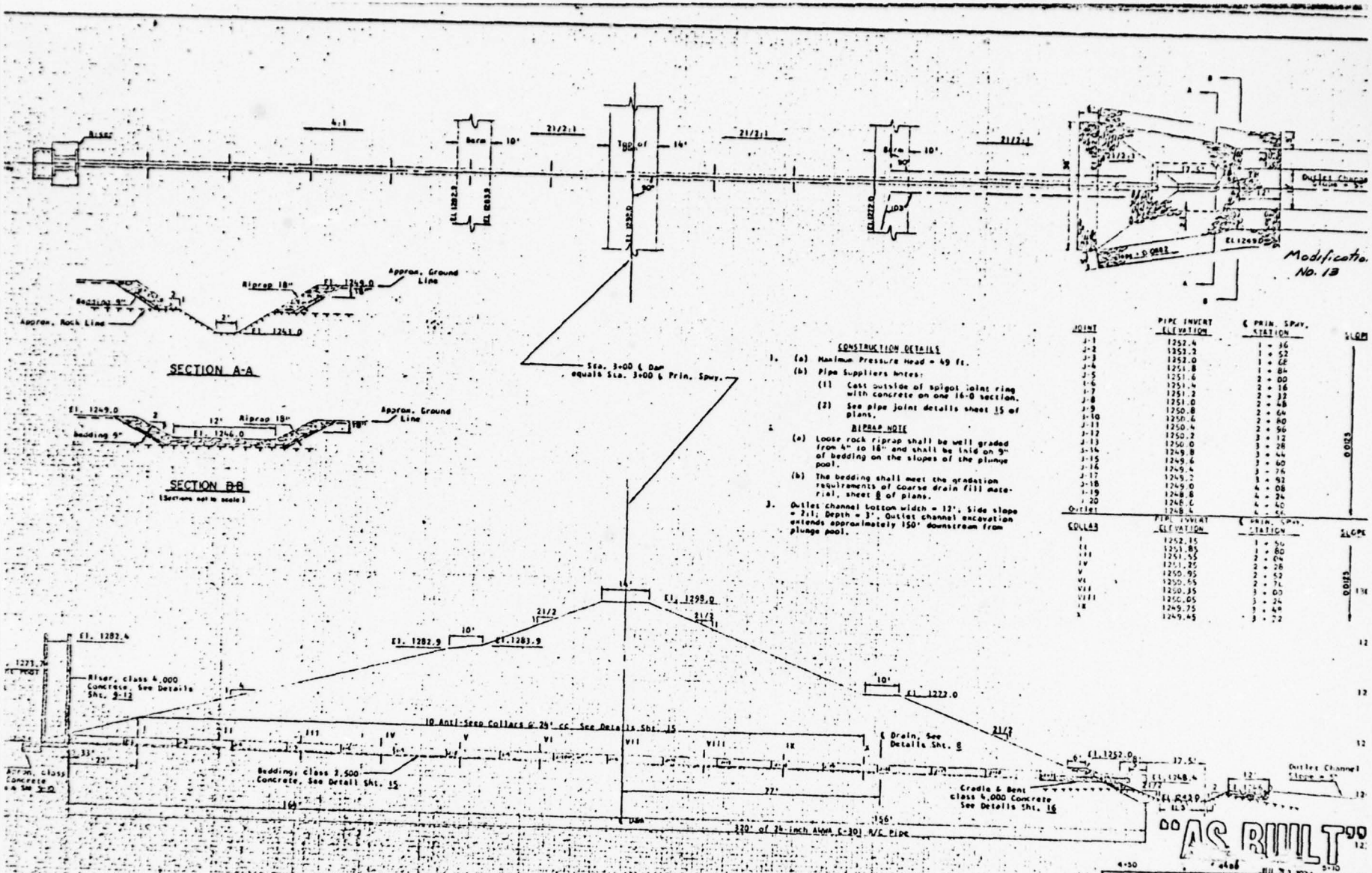
Excavation limits are approximate and are adjusted in accordance with conditions encountered.

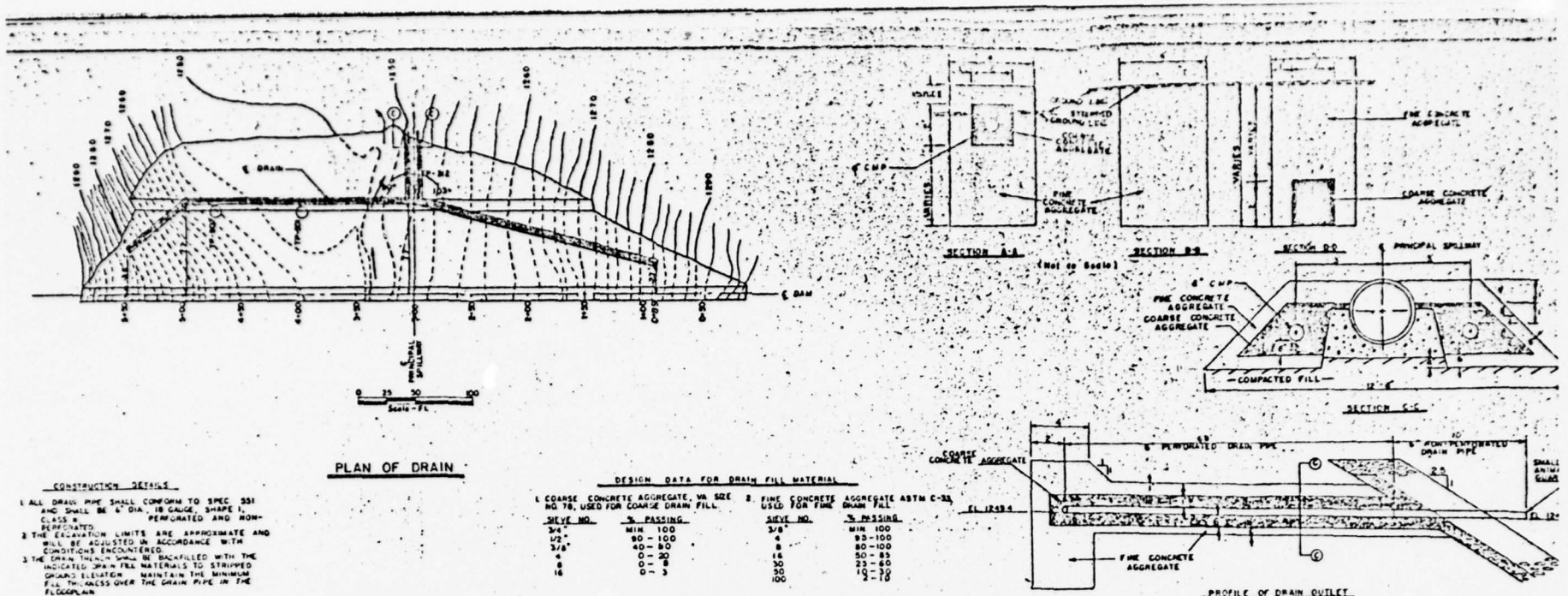


TYPICAL SECTION OF OLD CHANNEL CLEAN OUT

(Not to Scale)




Riser
4:1
Berm 10'
21/2:1
Top of Dam
16'
21/2:1
Berm 10'
21/2:1
Outlet Channel
EL 1249.0
Modification No. 13
Approx. Ground Line
Riprap 18"
Bedding 9"
Approx. Rock Line
SECTION A-A
SECTION B-B
(Sections not to scale)
Sta. 3+00 ℄ Dam equals Sta. 3+00 ℄ Prin. Spwy.
CONSTRUCTION DETAILS
1. (a) Maximum Pressure Head = 49 ft.
(b) Pipe Suppliers Notes:
(1) Cast outside of spigot joint ring with concrete on one 16-ft section.
(2) See pipe joint details sheet 15 of plans.
2. RIPRAP NOTE
(a) Loose rock riprap shall be well graded from 4" to 18" and shall be laid on 9" of bedding on the slopes of the plunge pool.
(b) The bedding shall meet the gradation requirements of coarse drain fill material, sheet 8 of plans.
3. Outlet channel bottom width = 12', Side slope = 2:1; Depth = 3'. Outlet channel excavation extends approximately 150' downstream from plunge pool.
JOINT | PIPE INVERT ELEVATION | ℄ PRIN. SPWY. STATION | SLOPE
J-1 1252.4 1 + 36
J-2 1251.2 1 + 52
J-3 1252.0 1 + 68
J-4 1251.8 1 + 84
J-5 1251.6 2 + 00
J-6 1251.4 2 + 16
J-7 1251.2 2 + 32
J-8 1251.0 2 + 48
J-9 1250.8 2 + 64
J-10 1250.6 2 + 80
J-11 1250.4 2 + 96
J-12 1250.2 3 + 12
J-13 1250.0 3 + 28
J-14 1249.8 3 + 44
J-15 1249.6 3 + 60
J-16 1249.4 3 + 76
J-17 1249.2 3 + 92
J-18 1249.0 4 + 08
J-19 1248.8 4 + 24
J-20 1248.6 4 + 40
Outlet 1248.4 4 + 56
0.0025
COLLAR | PIPE INVERT ELEVATION | ℄ PRIN. SPWY. STATION | SLOPE
I 1252.15 1 + 50
II 1251.85 1 + 80
III 1251.55 2 + 04
IV 1251.25 2 + 28
V 1250.95 2 + 52
VI 1250.65 2 + 76
VII 1250.35 3 + 00
VIII 1250.05 3 + 24
IX 1249.75 3 + 48
X 1249.45 3 + 72
0.0025
EL 1298.0
EL 1282.9
EL 1283.9
EL 1282.4
EL 1273.76 INVERT
EL 1222.0
EL 1252.0
EL 1248.4
EL 1249.0
Riser, class A 4,000 Concrete, See Details Sht. 9-12
10 Anti-Seep Collars @ 29' c-c See Details Sht. 15
Bedding; Class 2,500 Concrete, See Detail Sht. 15
℄ Drain, See Details Sht. 8
Cradle & Bent class B,000 Concrete See Details Sht. 16
330' of 24-inch AWWA C-301 R/C PIPE
Scale - Ft.
PRINCIPAL SPILLWAY LAYOUT
"AS BUILT"
UPPER BLACKWATER RIVER WATERSHED
DAM NO. 4
FRANKLIN COUNTY, VIRGINIA
PRINCIPAL SPILLWAY LAYOUT
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
C. B. CURRIN
J. F. RUSSELL 9/72
J. F. RUSSELL
PLATE IV



CONSTRUCTION DETAILS

1. ALL DRAIN PIPE SHALL CONFORM TO SPEC 551 AND SHALL BE 6" DIA., 18 GAUGE, SHAPE I, CLASS A PERFORATED AND NON-PERFORATED.
2. THE EXCAVATION LIMITS ARE APPROXIMATE AND WILL BE ADJUSTED IN ACCORDANCE WITH CONDITIONS ENCOUNTERED.
3. THE DRAIN TRENCH SHALL BE BACKFILLED WITH THE INDICATED DRAIN FILL MATERIALS TO STRIPPED GROUND ELEVATION. MAINTAIN THE MINIMUM FILL THICKNESS OVER THE DRAIN PIPE IN THE FLOODPLAIN.

DESIGN DATA FOR DRAIN FILL MATERIAL

1. COARSE CONCRETE AGGREGATE, VA SIZE NO. 78, USED FOR COARSE DRAIN FILL.

SIEVE NO.	% PASSING
3/4"	MIN 100
1/2"	90 - 100
3/8"	40 - 80
4	0 - 20
8	0 - 8
16	0 - 3

2. FINE CONCRETE AGGREGATE ASTM C-33 USED FOR FINE DRAIN FILL.

SIEVE NO.	% PASSING
3/8"	MIN 100
4	95 - 100
8	80 - 100
16	50 - 85
30	25 - 60
50	10 - 30
100	2 - 10

QUANTITIES

CU YDS COARSE CONCRETE AGGREGATE	50
CU YDS FINE CONCRETE AGGREGATE	5
LF 6" CONCRETE PERFORATED PIPE	120
LF 6" CONCRETE NON-PERFORATED PIPE	30
SMALL ANIMAL GUARDS	2
METAL END CAPS	2
90° 6" ELBOWS, 3-PIECE	2

UPPER BLACKWATER RIVER WATERSHED
DAM NO. 4
FRANKLIN COUNTY, VIRGINIA
DRAIN LAYO

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

E.B. CURRIN — Date
J.L. BURDETT — Designed by
J.L. BURDETT — Traced by

PLATE V

TEST PITS

STA. 0+50 ℄ DAM ELEV. 1291.0
JC 7/8/70

0	0.5	Silt, clayey, red, w/grass roots - topsoil	(ML)
0.5	11.8+	Sand, silt*, yellow-red to white, hard, damp - weathered granite - dry hole	(SM)

STA. 1+00 ℄ DAM ELEV. 1280.7
JC 7/8/70

0	0.5	Clay, silty, red, w/grass roots - topsoil	(CL)
0.5	9.0	Sand, silty, yellow-red to yellow-white, hard, damp, w/mica and feldspar	(SM)
9.0	10.6+	Gravel, sand*, w/silt, yellow, hard, moist, +4 est. 15% as angular blocks of weathered granite - digs hard	(GM)

STA. 1+50 ℄ DAM ELEV. 1270.4
JC 7/8/70

0	0.5	Clay, silty, red, w/grass roots - topsoil	(CL)
0.5	4.0	Gravel, silty, red, hard, moist, +4 est. 50% as sub-angular quartz and granite cobbles and boulders	(GM)
4.0	11.5	Sand, silty, yellow to olive-brown, hard, moist, micaceous, w/feldspar - weathered granite	(SM)
11.5		Refusal - dry hole	

STA. 2+00 ℄ DAM - ELEV. 1261.0
JC 7/8/70

0	0.5	Clay, silty, red, w/grass roots - topsoil	(CL)
0.5	6.75	Clay, silty, dk red-brown, stiff to hard, moist	(CL)
		DS 4-1 1.0-6.75	CL
6.75	8.5	Sand, silty, w/gravel, yellow, hard, moist, w/feldspar and fine mica; weathered granite	(SM)
8.5		Refusal - dry hole	

STA. 2+50 ℄ DAM ELEV. 1257.2
JC 7/8/70

0	0.5	Clay, silty, red, w/grass roots - topsoil	(CL)
0.5	3.4	Clay, silty, red, stiff to hard, moist	(CL)
3.4	6.0	Sand, fine, silty, brown, soft to firm, wet, sticky	(SM)
6.0	7.75	Sand, silty, lt gray w/brown mottles, soft, wet, w/mica - water table 6.4	(SM)
7.75	9.5	Gravel, sandy, w/silt, grey, hard, wet, +4 est. 80% as subrounded to subangular quartz pebbles and cobbles	(GM)
9.5	11.0	Sand, silty, gray, hard, wet, micaceous, w/feldspar - weathered granite	(SM)
11.0		Refusal	

STA. 3+00 ℄ DAM ELEV. 1252.9
JC 7/8/70

0	0.5	Clay, silty, red, w/grass roots - topsoil	(CL)
0.5	1.5	Clay, silty, red, hard, dry to moist	(CL)
1.5	4.8	Silt, sandy, to sand, fine, silty, olive-brown to lt gray, soft, wet - water table 3.0	(ML-SM)
		DS 6-1 1.5-4.8	CL
4.8	7.0	Weathered granite; digs as 12-18" angular boulders	(GM)
7.0		Refusal	

STA. 3+50 ℄ DAM ELEV 1284.8
JC 7/8/70

0	0.5	Silt, clayey, red, w/leaves	(ML)

TP 7 Cont'd

0.5	2.0	Silt, clayey, red, hard, damp, w/mica	(ML)
2.0	4.4	Sand, silty, yellow-brown, hard, damp, micaceous	(SM)
4.4		Refusal on weathered granite - dry hole	

TP 8 STA 3+00 ℄ DAM ELEV. 1271.9
JC 7/8/70

0.0	0.5	Silt, clayey, red, w/leaves and roots - topsoil	(ML)
0.5	4.0	Clay, silt*, red, hard, moist	(CL)
4.0	8.5	Silt, clayey to sandy, yellow-red to yellow-brown, hard, moist w/fine mica	(ML)
8.5		Refusal on weathered granite - dry hole	

TP 9 STA. 4+50 ℄ DAM ELEV. 1259.3
JC 7/8/70

0.0	0.5	Clay, silty, red, w/grass roots - topsoil	(CL)
0.5	5.8	Weathered granite, digs as angular 12" boulders, w/feldspar, quartz and hornblende	(GM)
5.8		Refusal - dry hole	

TP 10 STA 4+00 ℄ DAM ELEV. 1254.5
JC 7/8/70

0.0	0.5	Sand, fine, silty, red, w/grass roots - topsoil	(SM)
0.5	4.0	Sand, silty red, hard, damp	(SM)
		DS 10-1 1.0-4.0	SM
4.0	9.2	Sand, fine, silty, olive-brown, hard, moist, micaceous, w/feldspar; water table 9.0	(SM)
9.2		Refusal - weathered granite	

TP 11 STA 3+50 ℄ DAM ELEV. 1252.7
JC 7/8/70

0.0	0.5	Sand, silty, red-brown, w/grass roots - topsoil	(SM)
0.5	3.0	Sand, silty, red, hard, damp to moist	(SM)
3.0	5.0	Sand, silty, medium, gray, soft, wet - water table 4.4	(SM)
		DS 11-1 3.0-5.0	ML
5.0	6.5	Gravel, sandy, w/silt, gray, loose, wet, +4 est. 80% as subrounded to subangular quartz pebbles and cobbles	(GM)
6.5		Refusal on weathered granite	

TP 101 155' L STA 0+10 ℄ DAM ELEV. 1265.5
JC 7/8/70

0.0	0.5	Clay, silty, red, w/grass roots - topsoil	(CL)
0.5	2.5	Clay, silty, red, hard, damp	(CL)
2.5	6.5+	Sand, fine, silty, lt gray, white and brown - speckled, w/mica and feldspar - dry hole	(SM)
		DS 101-1 2.5-6.5+	ML

TP 102 595' L STA 0+65 ℄ DAM ELEV. 1273.5
JC 7/7/70

0.0	0.5	Silt, clayey, brown, w/grass roots - topsoil	(ML)
0.5	6.0	Gravel, sandy, w/silt, brown and yellow, hard, moist, +4 est. 80% as subrounded granite cobbles	(GM)
6.0	11.0+	Sand, silty, dk red-brown, hard, moist to wet, w/feldspar and fine mica - water table 9.3	(SM)
		DS 102-1 6.0-11.0+	SM

TP 103 595' L STA 2+27 ℄ DAM ELEV. 1264.5
JC 7/7/70

0.0	0.5	Silt, sandy, red-brown, w/grass roots - topsoil	(ML)

TP 103 Cont'd

0.5	1.75	Silt, sandy, red-brown, hard, moist	(ML)
1.75	3.5	Sand, silty, lt gray, stiff, moist	(SM)
3.5		Water table	
3.5	4.0	Gravel, sandy, w/silt, brown, loose, wet, +4 est. 80%, as subrounded quartz and granite pebbles and cobbles	(GM)
4.0	10.2+	Sand, coarse, silty brown, hard, wet, w/feldspar, quartz, and mica - weathered granite	(SM)

TP 104 420' L STA 2+12 ℄ DAM. ELEV. 1264.6
JC 7/7/70

0.0	0.5	Clay, silty, red, w/grass roots - topsoil	(CL)
0.5	3.0	Silt, sandy, red-brown, hard, moist	(ML)
3.0	5.5	Sand, silty, lt brown, hard, moist to wet	(SM)
5.5	7.0	Gravel, sandy, w/silt, brown, loose, wet, +4 est. 80%, as subrounded quartz pebbles and cobbles; water table 6.0	(GM)
7.0	9.0	Sand, silty, coarse, brown, hard, wet, w/feldspar and fine mica - weathered granite	(SM)
9.0		Refusal	

TP 105 425' L STA 3+65 ℄ DAM. ELEV. 1261.4
JC 7/7/70

0.0	0.5	Silt, sandy, red, w/grass roots - topsoil	(ML)
0.5	1.75	Silt, sandy, red, hard, dry to moist	(ML)
1.75	3.5	Sand, silty, lt gray, stiff, moist	(SM)
3.5		Water table	
3.5	4.3	Gravel, sandy, w/silt, brown, loose, wet, +4 est. 80%, as subrounded quartz pebbles and cobbles	(GM)
4.3	8.0	Sand, silty, coarse, brown, hard, wet, w/feldspar and fine mica - weathered granite	(SM)
8.0		Refusal	

TP 106 300' L STA 2+20 ℄ DAM. ELEV. 1264.9
7/7/70

0.0	0.5	Clay, silty, red, w/grass roots - topsoil	(CL)
0.5	2.75	Clay, sandy, w/silt, red-brown, hard, dry to moist	(CL)
2.75	4.35	Silt, clayey, lt gray, hard, moist	(ML)
4.35	8.1	Sand, silty, coarse, brown, hard, moist to wet, w/feldspar and fine mica - weathered granite - water table 8.1	(SM)
8.1		Refusal	

TP 107 260' L STA 3+00 ℄ DAM. ELEV. 1258.3
JC 7/7/70

0.0	0.5	Silt, sandy, w/clay, red, w/grass roots - topsoil	(ML)
0.5	2.0	Silt, clayey, red, firm, moist	(ML)
		DS 107-1 1.0-2.0	CL
2.0	4.0	Sand, silty, gray, soft, wet	(SM)
4.0		Water table	
4.0	5.0	Gravel, sandy, w/silt, brown, loose, wet, +4 est. 80% as subrounded quartz pebbles and cobbles	(GM)
5.0	6.0	Sand, silty, brown, hard, wet, w/feldspar and mica - weathered granite	(SM)
6.0		Refusal	

TP 108 290' L STA 1+45 ℄ DAM. ELEV. 1271.7
JC 7/7/70

0.0	0.5	Clay, silty, red, w/grass roots - topsoil	(CL)
0.5	3.75	Clay, silty, dk red, hard, dry to moist	(CL)
3.75	10.5+	Sand, silty, yellow-brown, hard, moist, w/feldspar and mica - weathered granite - dry hole	(SM)

TP 109 395' L STA 1+95 ℄ DAM. ELEV. 1270.8
JC 7/7/70

0.0	0.5	Clay, silty, red w/grass roots - topsoil	(CL)
0.5	1.75	Clay, silty, red, hard, dry	(CL)
1.75	7.0	Gravel, sandy, w/silt, brown, hard, damp, +4 est. 80%, as subrounded granite cobbles; max. size 9" - alluvium	(GM)
7.0		Refusal - dry hole	

TP 110 500' L STA 1+23 ℄ DAM. ELEV. 1272.5
JC 7/7/70

0.0	0.5	Clay, silty, red, w/grass roots - topsoil	(CL)
0.5	2.0	Clay, silty, red, hard, dry	(CL)
2.0	5.5	Gravel, sandy, w/silt, brown, hard, moist +4 est. 80%, as subrounded granite cobbles - terrace alluvium	(GM)
		DS 110-1 2.0-5.5	GC-GM
5.5	9.7+	Sand, silty, dk brown, hard, moist - dry hole	(SM)

TP 201 [illegible] STA. 1+[illegible] ℄ DAM ELEV. 1295.8
JC 7/8/70

0.0	0.5	Silt, clayey, brown, w/grass roots - topsoil	(ML)
0.5	4.5	Clay, silty, red, hard, moist, occasional quartz cobbles	(CL)
4.5	12.3+	Silt, sandy, yellow-red, hard, moist, w/fine mica - weathered granite - dry hole	(ML)

TP 202 [illegible] STA. [illegible] ℄ DAM ELEV. 1303.1
JC 7/8/70

0.0	0.5	Silt, clayey, brown, w/grass roots - topsoil	(ML)
0.5	7.2	Clay, silty, red, hard, moist, to silt, clayey	(CL-ML)
		DS 202-1 1.0-7.2	MH
7.2	12.0+	Sand, silty, yellow hard, moist, w/rounded granite cobbles - weathered granite - dry hole	(SM)

TP 203 [illegible] STA. [illegible] ℄ DAM ELEV. 1311.9
JC 7/8/70

0.0	0.5	Silt, clayey, brown, w/grass roots - topsoil	(ML)
0.5	7.5	Clay, silty, red, hard, moist	(CL)
7.5	10.75+	Silt, sandy, w/clay, red, hard, moist, w/fine mica; digs hard - dry hole	(ML)
		DS 203-1 7.5-10.75+	CL

TP 204 12'R STA 2+24 [illegible] ELEV. 1309.5
JC 7/8/70

0.0	0.5	Silt, clayey, red, w/grass roots - topsoil	(ML)
0.5	7.0	Clay, silty, red, hard, moist	(CL)
7.0	13.0+	Sand, fine, silty, yellow-brown, hard, moist; micaceous - dry hole	(SM)

TP 205 62'R STA 3+17 ℄ DAM. ELEV. 1316.8
JC 7/8/70

0.0	0.5	Silt, clayey, red, w/grass roots - topsoil	(ML)
0.5	5.35	Clay, silty, red, hard, moist	(CL)
5.35	11.5+	Silt, sandy, to sand, fine, silty, yellow-brown, hard, moist, w/fine mica -	(ML-SM)

TP 206 STA. [illegible] ℄ DAM ELEV. 1305.4
JC 7/8/70

0.0	0.5	Silt, clayey, red, w/grass roots - topsoil	(ML)
0.5	6.0	Clay, silty, red hard, moist	(CL)
6.0	11.0+	Sand, silty, yellow, hard, moist, w/fine mica - dry hole	(SM)
		DS 206-1 6.0-11.0+	ML

TP 207 [illegible] STA. [illegible] ℄ DAM ELEV. 1309.0
JC 7/8/70

0.0	0.5	Silt, clayey, red, w/grass roots - topsoil	(ML)
0.5	6.0	Clay, silty, red hard, moist	(CL)
6.0	11.75+	Sand, fine, silty, yellow to yellow-white, hard, moist, w/fine mica and weathered feldspar - weathered granite - dry hole	(SM)

TP 208 STA. [illegible] ℄ DAM ELEV. 1296.0
JC 7/8/70

0.0	0.5	Silt, clayey, red, w/grass roots - topsoil	(ML)
0.5	5.25	Clay, silty, red, hard, moist	(CL)
5.25	10.5+	Sand, silty fine, yellow-brown, hard, moist, micaceous - w/manganese staining - dry hole	(SM)

TP 209 [illegible] STA. [illegible] ℄ DAM ELEV. 1294.7
JC 7/8/70

0.0	0.5	Silt, clayey, red, w/grass roots - topsoil	(ML)
0.5	6.5	Clay, silty, red, hard moist	(CL)
6.5	10.25+	Silt, sandy, yellow-red, hard, moist, w/fine mica - dry hole	(ML)

TP 301 STA. 2+50 ℄ PIPE ELEV. 1253.5
JC 7/8/70

0.0	0.5	Clay, silty, red, w/grass roots - topsoil	(CL)
0.5	1.5	Clay, silty, red, hard, dry to damp	(CL)
1.5	3.25	Sand, fine, silty, lt brown and grey - mottled, firm, moist to wet	(SM)
		DS 301-1 1.5-3.25	ML
3.25	6.0	Weathered granite, digs as angular boulders and cobbles - water table 4.0	(GM)
6.0		Refusal	

TP 302 STA. 3+00 ℄ PIPE ELEV. 1254.5
JC 7/8/70

0.0	0.5	Silt clayey, red, w/grass roots - topsoil	(ML)
0.5	1.4	Sand, fine, silty, red-brown, hard, moist	(SM)
1.4	3.0	Sand, medium, silty, gray, soft, wet, w/quartz, feldspar and mica	(SM)
3.0	4.3	Gravel, sandy, w/silt, gray, loose, wet, +4 est. 80%, as	(GM)

AS BUILT

UPPER BLACKWATER RIVER WATERSHED
DAM SITE No. 4
FRANKLIN COUNTY, VA.
LOGS OF TEST HOLES

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Investigated by J.W. GAFFNEY, C.W. TONEY	Date 7/78	Approved by State Conservationist (Retired)
Typed by Ruth Hall		
Checked by J.W. Ga		

PLATE V1

(Cont'd)

7.4		Sand, silty, olive-brown, hard, wet, w/feldspar and mica - weathered granite	(SM)
		Refusal	

STA. 1+40 ℄ PIPE ELEV. 1245.7
JC 776/70

0.0	0.5	Silt, clayey, red, w/grass roots - topsoil	(ML)
0.5	1.5	Silt, sandy, w/clay, red, hard, moist	(ML)
1.5	4.2	Sand, silty, gray, soft, wet, w/quartz and feldspar - some mica	(SM)
		Water table	
4.2	6.0	Gravel, sandy, w/silt, gray-brown, loose, wet, +4 est. 80%, as subangular to sub-rounded quartz pebbles and cobbles	(GM)
6.0	9.0	Sand, silty, olive-brown, hard, wet, w/feldspar and mica - weathered granite	(SM)
		Refusal	

STA. 3+50 ℄ PIPE ELE. 1252.9

0.0	0.5	Silt, clayey, red, w/grass roots - topsoil	(ML)
0.5	2.5	Silt, clayey, lt red, hard, dry to damp	(ML)
2.5	5.0	Sand, silty, dk green-gray, hard, wet, w/feldspar and mica - water table 4.0	(SM)
		Refusal on weathered granite	

STA. 4+00 ℄ PIPE ELEV. 1252.0
JC 776/70

0.0	0.5	Silt, clayey, red-brown, w/grass roots - topsoil	(ML)
0.5	3.0	Silt, clayey, w/fine sand, red-brown, hard, dry to damp	(ML)
3.0	4.8	Sand, silty, lt gray, hard, moist, w/quartz, feldspar and mica - weathered granite - water table 4.7	(SM)
		Refusal	

STA. 4+50 ℄ PIPE ELEV. 1251.1
JC 776/70

0.0	0.5	Silt, clayey, red-brown w/grass roots - topsoil	(ML)
0.5	3.0	Silt, sandy, red-brown, hard, dry to damp	(ML)
		DS 306-1 1.0-3.0	ML
3.0	4.8	Gravel, sandy, w/silt, brown, hard, moist, as weathered granite and vein quartz	(GM)
		Refusal - dry hole	

STA. 5+00 ℄ PIPE ELEV. 1249.8
JC 776/70

0.0	0.5	Silt, clayey, red, w/grass roots - topsoil	(ML)
0.5	4.0	Silt, sandy, red-brown, hard, dry to damp	(ML)
4.0	5.4	Gravel, sandy, w/silt, brown, hard, moist +4 est 80% as quartz and granite pebbles and cobbles	(GM)
5.4	8.5	Sand, silty, dk brown, hard, moist to wet, w/feldspar and mica - weathered granite - refusal - water table 8.35	(SM)

STA. 1+75 ℄ PIPE ELEV. 1255.3
JC 775/70

0.0	0.5	Clay, silty, red, w/grass roots - topsoil	(CL)
0.5	2.35	Silt, clayey, w/sand, red, hard, moist	(ML)
2.35	4.5	Sandy silty, blue-gray, stiff, wet	(SM)
		Water table	

TP 308 Cont'd.

4.5	5.5	Gravel, sandy, w/silt, gray, loose, wet, +4 est. 80% as quartz pebbles and cobbles	(GM)
5.5		Refusal on weathered granite	

TP 309 STA. 2+25 ℄ PIPE ELEV. 1251.9
JC 776/70

0.0	0.5	Silt, sandy, red, w/grass roots - topsoil	(ML)
0.5	1.5	Silt, sandy, red-brown, firm, moist	(ML)
1.5	3.0	Sand, fine, silty, lt blue-gray, soft, wet	(SM)
3.0		Water table	
3.0	5.7	Gravel, sandy, w/silt, gray, hard, wet, +4 est. 80%, as subrounded quartz and granite pebbles and cobbles	(GM)
5.7	7.7	Sand, silty, brown, hard, wet, w/feldspar and mica	(SM)
7.7		Refusal on weathered granite	

TP 310 STA. 2+75 ℄ PIPE ELEV. 1253.3
JC 775/70

0.0	0.5	Clay, silty, red, w/grass roots - topsoil	(CL)
0.5	2.0	Clay, silty, red, hard, damp to moist	(CL)
		DS 310-1 1.0-2.0	CL
2.0	4.0	Silt, sandy, to sand, silty, lt gray, firm, moist to wet	(ML-SM)
4.0		Water table	
4.0	6.0	Gravel, sandy, w/silt, gray, hard, wet, +4 est. 80%, as subrounded quartz and granite pebbles and cobbles	(GM)
6.0		Refusal on granite	

TP 311 STA. 3+25 ℄ PIPE ELEV. 1252.9
JC 775/70

0.0	0.5	Clay, silty, red, w/grass roots - topsoil	(CL)
0.5	2.0	Clay, silty, red, hard, dry to moist	(CL)
2.0	5.5	Silt, sandy, to sand, silty, lt grey, soft, moist to wet - water table 3.0	(ML)
		US 311-1 2.0-5.5	ML
5.5	7.2	Gravel, sandy, w/silt, lt gray-brown, loose, wet, +4 est. 75%, as quartz pebbles	(GM)
7.2		Refusal on granite	

TP 312 STA. 3+75 ℄ PIPE ELEV. 1252.6
JC 775/70

0.0	0.5	Clay, silty, red, w/grass roots - topsoil	(CL)
0.5	2.4	Silt, clayey, red-brown, hard, dry to damp	(ML)
2.4	4.0	Sand, silty, dk brown, hard, w/feldspar and hornblende - moist to wet - water table 3.9	(SM)
4.0		Refusal on granite	

TP 313 STA. 4+25 ℄ PIPE ELEV. 1251.2
JC 775/70

0.0	0.5	Silt, clayey, red, w/grass roots - topsoil	(ML)
0.5	2.6	Clay, silty, red, hard, dry to damp	(CL)
2.6	3.4	Gravel, sandy, w/silt, gray, hard, moist, +4 est. 80% as quartz pebbles and cobbles	(GM)
3.4	6.3	Sand, silty, dk brown, hard, moist to wet, w/feldspar and hornblende - water table 5.75	(SM)
6.3		Refusal on granite	

TP 314 STA. 4+75 ℄ PIPE ELEV. 1249.4
JC 775/70

0.0	0.5	Silt, sandy, red-brown, w/grass roots - topsoil	(ML)
0.5	3.5	Silt, sandy, red-brown, hard, dry	(ML)
3.5	5.0	Gravel, sandy, w/silt, brown, hard, moist, digs as 12" subangular granite blocks	(GM)
5.0		Refusal in weathered granite - dry hole	

TP 501 75' ℞ STA. 4+00 ℄ DAM ELEV. 1250.8
JC 776/70

0.0	0.5	Sand, silty, red, w/grass roots - topsoil	(SM)
0.5	3.5	Sand, silty, red, hard, damp to moist	(SM)
3.5	5.6	Sand, silty, gray, soft, wet, w/mica - water table 5.5	(SM)
5.6	7.4	Gravel, sandy, w/silt, grby and brown, loose, wet, +4 est. 80%, as subangular to sub-rounded quartz pebbles and cobbles	(GM)
7.4	9.0	Sand, silty, w/gravel, gray, hard, wet, w/feldspar and mica - weathered granite	(SM)
9.0		Refusal	

TP 502 75' ℞ STA. 4+75 ℄ DAM ELEV. 1254.2
JC 776/70

0.0	0.5	Clay, silty, red, w/grass roots - topsoil	(CL)
0.5	8.0	Clay, silty, red, hard, moist	(CL)
8.0	10.7	Gravel, sandy, w/silt, brown, hard, moist to wet, +4 est. 70%, as quartz and granite pebbles and cobbles - water table 9.0	(GM)
10.7		Refusal on granite	

LEGEND

TEST HOLE NUMBERING SYSTEM

001 - 099	Centerline of Dam
101 - 199	Borrow Area
201 - 299	Emergency Spillway
301 - 399	Principal Spillway
401 - 499	Foundation
501 - 599	Foundation Drain - Relief Well
601 - 699	Other (Locate)

Hole numbers are not repeated.

TEST HOLE NUMBER PREFIX

HA - Hand Auger
DH - Drill Hole - Rotary
TP - Test Pit - Backhoe or Dozer

SAMPLE TYPES

DS - Disturbed Sample (Loose, Mixed, Bagged)
US - Undisturbed (Sealed Block or Tube Type)
RC - Rock Core (Diameter)
SpT - Drive Sample - Standard Penetration Tube (Disturbed in Jar)

SAMPLE NUMBER

DS 101-1 - Disturbed from Hole No. 101, Sample No. 1
US 3-3 - Undisturbed from Hole No. 3, Sample No. 3
SpT 10.16 - Drive Sample from Hole No. 10, Sample No. 16

UNIFIED SOIL CLASSIFICATION SYMBOLS

GW - Well-graded gravels and gravel-sand mixtures, little or no fines.
GP - Poorly graded gravels and gravel-sand mixtures, little or no fines.
GM - Silty gravels, gravel-sand-silt mixtures.
GC - Clayey gravels, gravel-sand-clay mixtures.
SW - Well-graded sands and gravelly sands, little or no fines.
SP - Poorly graded sands and gravelly sands, little or no fines.
SM - Silty sands, sand-silt mixtures.
SC - Clayey sands, sand-clay mixtures.
ML - Inorganic silts, very fine sands, rock flour, silty or clayey fine sands
CL - Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
MH - Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts.
CH - Inorganic clays of high plasticity, fat clays.

Based on Visual-Manual Procedure, ASTM D 2488

Precipitation:

7/9 1/2" rain

"AS BUILT"

JUL 31 1974

UPPER BLACKWATER RIVER WATERSHED
DAM SITE NO. 4
FRANKLIN COUNTY, VA.
LOGS OF TEST HOLES

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Investigated	Date	Approved	
J.W. GAITHEY C.W. TONEY	2/70	State Conservationist	
Drawn		Engineer	
Typed Keith McCarthy			
Traced			

PLATE V11

APPENDIX II

PHOTOGRAPHS

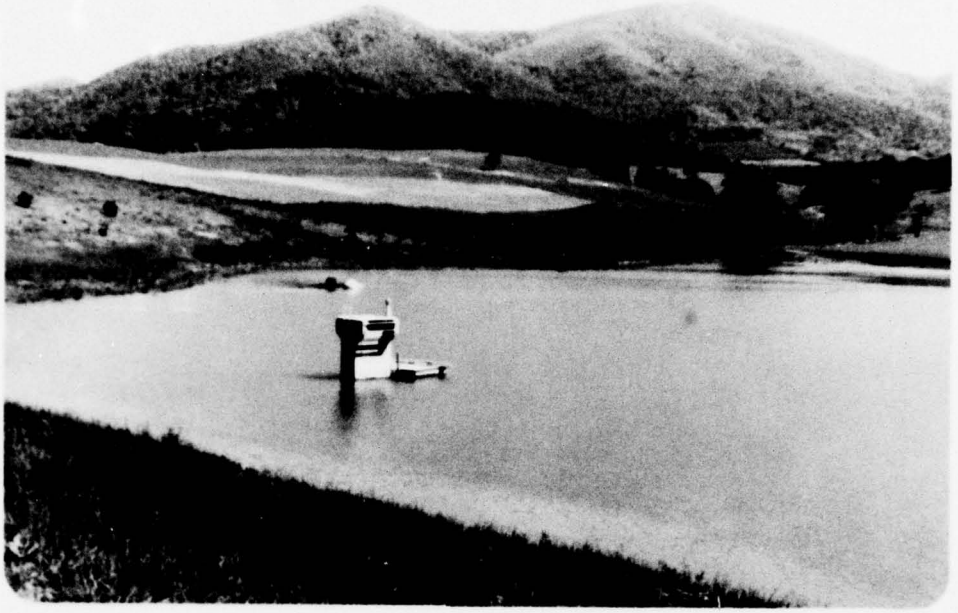


PHOTO #1 INTAKE STRUCTURE

PHOTO #2 OUTLET STRUCTURE

PHOTO #3 WET MARSHY AREA AT TOE TO LEFT OF PRINCIPAL SPILLWAY

PHOTO #4 WET MARSHY AREA IN FIELD BEYOND TOE OF DAM

PHOTO # 5 JUNCTION OF SUSPECTED FIELD DRAIN AND MAIN CHANNEL

PHOTO # 6 TYPICAL ANIMAL BURROW AT JUNCTION OF LT. ABUTMENT AND EMBANKMENT

APPENDIX III

FIELD OBSERVATIONS

Check List
Visual Inspection
Phase I

(VA I.D. NO. 06702)

Name Dam Upper Blackwater River #4 County Franklin State Virginia Coordinates Lat. 3704.7 Long 8002.2

Date(s) Inspection 5/17/79 Weather Clear Temperature 60°F

Pool Elevation at Time of Inspection 1273.7 m.s.l. Tailwater at Time of Inspection 1247± m.s.l.

Inspection Personnel:

Mr. Cyrus I. Dillon (Owner)
Stephen Hedrick (SCS) (BRS &WCD)
Robert Cheng (COE)
Hugh Gildea (SWCB)
Jim Robinson (COE)
B. O. Taran Recorder

SCS - Soil Conservation Service

BRS & WCD - Blue Ridge Soil and Water Conservation District

COE- Corps of Engineers

SWCB - State Water Control Board

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	No visible cracks were noted on any face of the dam.	None
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	No unusual movement or cracking was observed.	None
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	a. Upstream Slope Bare spots noted just above berm. b. Downstream Slope Toe of embankment has sloughed slightly just to right of principle spillway. c. General Numerous bare spots exist on all faces of embankment.	Vegetative protective cover on all faces of embankment should be thickened.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	No noticeable misalgnment was noted.	None
RIPRAP FAILURES	Riprap not used for embankment protection.	None

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CONDITION	A small shrub was noted on upstream slope. No severe erosion from wave action was noted on the upstream slope shoreline.	Shrub growth should be removed from slope.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Upstream - Animal burrows were noted in the junction of the left abutment just below the crest of the dam. Downstream - Animal burrows were noted in the junction of the left abutment below the crest of the dam. An erosion gully about 18" deep was noted on the left downstream junction.	The burrows and gullies should be watched closely and filled properly.
ANY NOTICEABLE SEEPAGE	A very wet area of standing water from 2" to 6" deep was noted at the toe of the dam just to the left of the principal spillway. This area was approx. 50 feet square and was covered with marsh grass. Similar type of marsh grass was noted in an extensive area approx. 100 feet down from toe of dam. The ground surface between these two marshy areas was soggy. *For additional comments see visual observations for downstream channel.	It was indicated by the owner that the field beyond the toe of the dam had always been wet due to springs and seepage. Years ago drain tile pipe was installed in the field to drain it and make it suitable for cropland. The possible remnants of these drainlines may be the lines described in the downstream channel observation notes.
STAFF GAGE AND RECORDER	No staff gage or recorder were noted.	Staff gage should be installed.
DRAINS	Water flowing from both drains was observed to be clear and flow was estimated to be less than one gallon per minute.	None

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None noted. Concrete saddle supporting outlet pipe appeared to be in excellent condition.	None
INTAKE STRUCTURE	The two level intake structure was observed to be in excellent condition.	None
OUTLET STRUCTURE	24-inch diameter concrete pipe flowing 1/6 full discharges freely into a rip rapped stilling basin.	None
OUTLET CHANNEL	Stilling basin extends approx.30 feet with riprap lining. Some small trees and shrubs are growing in the riprap. A narrow channel 10'wide lies below the basin with a flat overbank. Riprap around stilling basin appeared to be adequate.	Trees and shrubs should be removed in rip rapped area.
EMERGENCY GATE	The wheel to operate the sluice gate in intake structure was not in place.	Emergency gate wheel is stored at the caretaker's premises.

EMERGENCY SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
APPROACH CHANNEL	Approach channel of emergency spillway is in right abutment. The natural berm forming the left bank of the E.M.S. is relatively rather narrow.	Should the E.M.S. activate, the possibility exists that the left bank can be eroded to the extent that the crest of the dam would be endangered.
DISCHARGE CHANNEL	Appeared to be in good condition.	None.

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	NONE	NONE
OBSERVATION WELLS	NONE	NONE
WEIRS	NONE	NONE
PIEZOMETERS	NONE	NONE
OTHER	NONE	NONE

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Minor slope erosion was noted around the entire reservoir. 75% of the surrounding land is pastureland and 25% is wooded. Algae growth was noted around the entire waterline of the reservoir. Some debris was noted 2-3' below berm on U/S slope of embankment (high water mark).	NONE
SEDIMENTATION	Not investigated.	NONE

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Channel appeared in good condition. Evidence of subterranean flow existed.	None
SLOPES	Overbank slopes were wide.	None
APPROXIMATE NO. OF HOMES AND POPULATION	3 to 4 homes downstream with estimated population of 9 to 12 people.	None
DOWNSTREAM OBSERVATION	Four drainage pipes empty into the downstream channel from the left bank. Approx. 100 ft from the outlet pipe, water is flowing from an opening (12"$\pm$ in dia) thru the left bank. It was estimated that the flow rate was 10 G.P.M. This flow could not be correlated with the wet marshy areas addressed in the visual observation of the embankment.	None

APPENDIX IV

GEOLOGIC REPORT

Sheet 1 of 5
VA 618

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

GENERAL

State Virginia County Franklin ; ___ ¼, ___ ¼, Sec. ___, T ___ R ___ ; Watershed Upper Blackwater River
Subwatershed North Fork Blackwater River Fund class ___ (FP-2, WP-1, etc.) Site number 4 Site group 1 Structure class b
Investigated by Joshua W Gallery Geologist (signature and title) Equipment used Backhoe; Dozer (type, size, make, model, etc.) Date 7/70

SITE DATA

Drainage area size 1.88 sq. mi., 696.3 acres. Type of structure Earth Fill Purpose Flood Prevention
Direction of valley trend (downstream) S.W. Maximum height of fill 47 feet. Length of fill 565 f
Estimated volume of compacted fill required 89,900 yards

STORAGE ALLOCATION

	Volume (ac. ft.)	Surface Area (acres)	Depth at Dam (feet)
Sediment	162	11	20
Floodwater	226	26	38

SURFACE GEOLOGY AND PHYSIOGRAPHY

Physiographic description Piedmont Topography hilly to mountainous. Attitude of beds: Dip -- Strike --
Steepness of abutments: Left 23 percent; Right 17 percent. Width of floodplain at centerline of dam 180 fee
General geology of site: Upper Blackwater River site #4 is located in northwestern Franklin County, ten miles west-northwest of Rocky Mount, Virginia. The site lies on the North Fork of the Blackwater River. Coarse granite containing quartz, feldspar, mica, and hornblende underlies this site. Occasional vein quartz cuts the granite. The granite, gneissic in places, is exposed in the stream bottom, downstream from the centerline of the dam and also in the left upstream portion of the foundation.

Residual soil weathered from granite lies on the abutments. Colluvium mantles the lower right abutment, partly covering alluvium. Alluvial gravel, sand, silt, and clay covers weathered granite in the valley bottom.

USDA-SCS-HYATTSVILLE, MD. 1968

The site lies across a narrow valley bottom in Precambrian gneisses, near the southeast edge of the Virginia Blue Ridge complex.

The Lynchburg formation (Precambrian), lies just southeast of the site. The stream pattern is dendritic, and somewhat entrenched.

Methods and Procedures

1. The Unified Soil Classification System was used in describing soils encountered in the foundation, spillway, and borrow area.

2. All test pits were dug by backhoe. Twenty-five pound samples were taken of all significantly different materials in foundation and borrow areas. A one-gallon undisturbed sample was taken in the foundation.

Centerline of the Dam

The centerline of the dam crosses a narrow valley bottom between moderately steep abutments. On the left abutment, residual soil extends from 4+35 to the top of the dam. A red, hard CL-ML B-horizon, 2 - 4 feet thick, overlies 2.4 to 4.5 feet of hard, yellow-brown to yellow-red micaceous silty sand or sandy silt (C-horizon). Toward the toe of this abutment (sta. 4+50), the SM-ML C-horizon is replaced by 5.8 feet of angular granite boulder gravel, and the B-horizon is absent. Depth to rock (backhoe refusal) on this abutment is 4.4 to 8.5 feet.

Residual soil on the right abutment is thicker than that on the left. Yellow-red to white silty sand, 7.5 to 11.8 feet thick or more, overlies angular boulder gravel (weathered granite) or granite directly. The B-horizon is missing. In the vicinity of 1+50, subangular quartz and granite cobble and boulder gravel, 3.5 feet thick, overlies the residual SM and may be an old alluvial terrace remnant. Downslope from 2+50, 3.4 to 6.75 feet of red to red-brown colluvial CL overlie 1.75 feet of residual SM. The clay extends out over alluvium at the toe of the abutment.

In the valley bottom, the lowest alluvial layer is quartz pebble and cobble gravel with a silty sand matrix. The gravel lies in two separate lenses below the ℄ dam; one is at 3+50, 1.5 feet thick and resting directly upon hard granite. The gravel overlaps residual SM on the left and residual boulder gravel on the right. The other quartz gravel lense, 2.25 feet thick, underlies the right edge of the floodplain, above residual silty sand. Above the quartz gravel is gray silty sand or sandy silt, sometimes mottled brown, from 1.25 to 3.3 feet thick. Above this, in two separate areas, is red to red-brown silty sand, 2.0 - 3.5 feet thick. On the right, this silty sand is overlain by colluvial and alluvial silty clay. Depth to rock in the floodplain varies from 6.5 to 9.5 feet. The water table lay 3 to 9.2 feet below the surface at the time of investigation.

Eleven test pits were dug along the ℄ dam. They are numbered TP-1 to TP-11.

Centerline of Principal Spillway

The centerline of the principal spillway crosses the centerline of the dam at 3+00 ℄ dam and 3+00 ℄ pipe. The two centerlines form an angle of 90°. Alluvial materials similar to those described under the ℄ dam underlie the ℄ pipe. Lenses of quartz gravel, 1 - 2.7 feet thick, overlie either brown residual SM, residual boulder gravel, or hard granite. Gray silty sand or sandy silt, 1.5 - 3.5 feet thick, overlies either the gravel or weathered granite in the upstream half of the pipe location. Above the SM - ML is red clayey silt or silty clay, 1 - 3 feet thick, alternating along the pipe location with red to red-brown silty sand to sandy silt. Downstream from 3+25, these reddish soils overlie residual coarse sand or gravel directly, except for intervening alluvial gravel lenses at 4+75 and 5+00. Depth to rock varies from 4 to 9 feet below the surface. The rock line declines irregularly from 1246.5 feet elevation (1+50), to 1241.5 feet (5+00). The water table lay from 2.5 to 8.25 feet below ground at the time of investigation. Fourteen test pits were dug along the ℄ of the pipe. They are numbered TP-301 to TP-314.

Foundation

Alluvium similar to that described above lies in the foundation area (toe drain). On the left side, 1.8 feet of quartz gravel overlie residual gray silty sand weathered from granite. Soft, gray silty sand, 2 feet thick, overlies this gravel, and 3.5 feet of red silty sand makes up the top alluvial layer. The alluvial sands overlap red colluvial silty clay, 8 feet thick, at the toe of the left abutment. The clay overlies the alluvial quartz gravel, 2.7 feet thick at this point. To the right of the stream channel, the bedrock rises sharply from 9 feet to within 4 feet of the surface. The alluvium on the left wedges out against weathered granite (SM), and only 2 feet of alluvium, as clayey silt, overlie 1.6 feet of residual SM on the right side of the floodplain.

The water table lay 4 to 9 feet below ground. Two test pits were dug along the toe drain area. They are TP-501 and TP-502. Granite crops out in the upstream side of the foundation, about 50 feet left of sta. 4+00 ℄ dam.

Emergency Spillway

The emergency spillway is located in the right abutment. The centerline of the spillway curves across the centerline of the dam at about 62 feet right of 0+00 ℄ dam (looking downstream), at 2+75 ℄ EMS.

Residual red CL - ML, 4.5 - 7.5 feet thick, overlies yellow to yellow-brown silty sand or sandy silt. The SM - ML, 3 to 7.7 feet thick or more, is the C-horizon on granite.

At the upstream end of the outside edge, the C-horizon becomes red, sandy silt with clay. No rock was reached in the emergency spillway. Nine test pits were dug in the spillway. They are numbered TP-201 to TP-209.

Borrow Area

In addition to the emergency spillway, a borrow area was investigated for 500 feet upstream from the centerline of the dam. The major portion of the area lies to the right of the stream, as a steep hill rises almost directly from the left stream bank a short distance from the upstream toe of the dam. Borrow consists of alluvium, colluvium, and residual soil.

Alluvial soils are similar to those described elsewhere. Quartz and granite pebble and cobble gravel, 0.5 to 1.5 feet thick, is overlain by 1.75 to 2.5 feet of light gray to light brown silty sand. Red to red-brown sandy silt, 1.25 to 2.5 feet thick, overlie this. The ML becomes clayey in the downstream part of the borrow area, near the dam. From about 350 to 500 feet upstream from the dam is a strip of terrace alluvium made up of 2 feet of red, silty clay over 3.5 feet of granite cobble gravel. Underlying all alluvium is coarse, brown silty sand, 1.0 - 6.2 feet thick, weathered from granite.

On the lower right slopes, red-brown colluvial sandy clay with silt overlies light gray clayey silt, 1.5 to 1.75 feet thick. Residual granite SM, 4 feet thick, underlies the colluvium. In places the colluvial CL has washed over alluvial gravel. Upslope from the alluvial and terrace soils is residual soil weathered from granite. Red silty clay, 3.25 feet thick, overlies 7 feet or more of yellow-brown silty sand. These materials are probably continuous laterally with residual soil described in the emergency spillway.

On the left side of the stream, an area of red CL 2 feet thick overlies residual sand, 4 feet or more in thickness. This soil is flanked by a steep valley side on the left. The water table varied from 3.5 to 9.3 feet below ground at the time of investigation. The rock line lies from 6 to 11.5 feet or more below the surface. Ten test pits were dug in the borrow area. They are TP-101 to TP-110.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SAMPLE LIST
SOIL AND FOUNDATION INVESTIGATIONS

Location Franklin County, Virginia Owner _____

Watershed Upper Blackwater River Sub-watershed North Fork Blackwater River Site No. 4

Submitted by J. W. Gaffney Date Oct. 1970

Sent by Trans. Co. (carrier) Government B/L No. _____

Lab. No.	Field Sample No.	Sample Description		Depth		Type of Sample	
		Location	Grid or Station	From	To	Undist.	Dist.
	4-1	℄ Dam	2+00	1.0	6.75		x
	6-1	"	3+00	1.5	4.8		x
	10-1	"	4+00	1.0	4.0		x
	11-1	"	3+50	3.0	5.0		x
	101-1	Borrow area		2.5	6.5		x
	102-1	"		6.0	11.0		x
	107-1	"		1.0	2.0		x
	110-1	"		2.0	5.5		x
	202-1	Emergency Spwy	1+50 ℄	1.0	7.2		x
	203-1	"	2+00 Outside Edge	7.5	10.75		x
	206-1	"	3+50 ℄	6.0	11.0		x
	301-1	℄ Pipe	2+50	1.5	3.25		x
	302-1	"	2+00	3.0	4.3		x
	306-1	"	4+50	1.0	3.0		x
	310-1	"	2+75	1.0	2.0		x
	311-1	"	3+25	2.0	2.75	x	

Original to Soils Laboratory
Copy to E and WP Unit
Distribute other copies as directed by State Conservationist

VA 618.
Sheet 5 of 5 Sheets

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCS-376C
REV. 2-64
SHEET 1 OF 4
VA 618

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

WATERSHED	SUBWATERSHED	COUNTY	STATE
Upper Blackwater River	N. Fork Blackwater River	Franklin	Virginia

SITE NO.	SITE GROUP	STRUCTURE CLASS	INVESTIGATED BY: (SIGNATURE OF GEOLOGIST)	DATE
4	1	b	Joseph W. Galloway	10/70

FOR IN-SERVICE USE ONLY

INTERPRETATIONS AND CONCLUSIONS

1. Cutoff should be taken into solid granite bedrock at least as far as the top of the permanent pool. This may involve a cutoff trench depth of from 10 to 12 feet in the valley bottom and on the right abutment, and 6 - 8 feet on the left abutment. It is unlikely that cutoff can be extended to the top of the dam on hard granite in the right abutment before the spillway area is reached; however, a keyway a few feet into the hard residual SM may be desirable.

2. From outcrops and the blocky nature of boulders weathered from granite, it appears that a joint system is well-developed in the granite. Jointing may not be a serious leakage problem but this eventuality should be kept in mind and grouting employed if it is thought necessary.

3. The bedrock shelf on the right downstream toe may have to be sloped back to prevent differential settlement.

4. The pipe location seems to be the best feasible on this site. A clay cushion should be placed along the pipe trench to reduce differential settlement due to unevenness of the rock and variability of alluvial sediments.

5. Little or no non-rippable rock is present in the emergency spillway cut. However, the dam height is given in the work plan as being 2 feet higher than in the survey data (Sheet 1, SCS-35's). This would place a cemetery, on the right abutment, within the spillway cut. If the revised height is used, the spillway will have to be placed in the left abutment, with considerable rock removal needed.

6. There should be sufficient borrow to construct the embankment. Thirty thousand cubic yards will come from the emergency spillway. Good core material can be found in the red CL - ML layer in the spillway, and in colluvial and residual clay on the lower right hillslopes along the edge of the sediment pool. To gain additional core material, the right slopes can be cut back and the area flooded to save reseeding. See the correlation chart for placement of borrow materials.

7. All topsoil should be stockpiled for use as top dressing.

Upper Blackwater River			4		Va.		J. W. Gaffney		10/70	
DS 202-1	1.0-7.2	CL-ML	201	0.5-4.5	CL	Emergency Spillway	Core	10,000	B-horiz on granite	
			202	0.5-7.2	CL-ML	"	"		"	
			203	0.5-7.5	CL	"	"		"	
			204	0.5-7.0	CL	"	"		"	
			205	0.5-5.25	CL	"	"		"	
			206	0.5-6.0	CL	"	"		"	
			207	0.5-6.0	CL	"	"		"	
			208	0.5-5.25	CL	"	"		"	
			209	0.5-6.5	CL	"	"		"	
DS 203-1	7.5-10.75	ML)	201	4.5-12.2	ML	Emergency Spillway	Transitional and shell	20,000	C-horiz on granite	
DS 206-1	6.0-11.0	SM)	202	7.2-12.0	SM	"	"		"	
			203	7.5-10.75	ML	"	"		"	
			204	7.0-12.0	SM	"	"		"	
			205	5.25-11.5	ML-SM	"	"		"	
			206	6.0-11.0	SM	"	"		"	
			207	6.0-11.75	SM	"	"		"	
			208	5.25-10.5	SM	"	"		"	
			209	6.5-10.25	ML	"	"		"	

Upper Blackwater River 4 Va. J. W. Gaffney 10/70

DS 4-1	1.0-6.75	CL	106	0.5-2.75	CL	Lower Rt.slopes	Core	10,000	colluvi
			109	0.5-1.75	CL	"	"		"
DS 202-1	1.0-7.2	CL-ML	108	0.5-3.75	CL	Lower Rt.slopes	Core	10,000	B-horiz on granite
DS 306-1	1.0-3.0	ML)	103	0.5-1.75	ML	Flood-plain	Transitional or core	20,000	Alluviu and
DS 107-1	1.0-2.0	ML)	104	0.5-3.0	ML	"	"		terrace alluviu
			105	0.5-1.75	ML	"	"		"
			107	0.5-2.0	ML	"	"		"
			110	0.5-2.0	CL	"	"		"
DS 11-1	3.0-5.0	SM	103	1.75-3.5	SM	Flood-plain	Transitional or shell	20,000	Alluviur
			104	3.0-5.5	SM	"	"		"
			105	1.75-3.5	SM	"	"		"
			107	2.0-4.0	SM	"	"		"
)S 302-1	3.0-4.0	GM	102	0.5-6.0	GM	Flood-plain & Lower Rt.	Shell	15,000	Alluviur and
)S 110-1	2.0-5.5	GM	103	3.5-4.0	GM	slopes	"		terrace alluviur
			104	5.5-7.0	GM	"	"		"
			105	3.5-4.3	GM	"	"		"
			107	4.0-5.0	GM	"	"		"

Upper Blackwater River	4	Va.	J. W. Gaffney	10/70

DS 110-1	2.0-5.5	GM	109	1.75-7.0	GM	Floodplain & Lower Rt.slopes	Shell	15,000	Alluviu and terrace alluviu
			110	2.0-5.5	GM	"			
DS 101-1	2.5-6.5	SM)	101	2.5-6.5	SM	Lower Rt. & Lt. slopes	Tran-sitional or shell	15,000	C-horiz on granite
DS 102-1	6.0-11.0	SM)	102	6.0-11.0	SM	"	"		"
			106	4.25-8.3	SM	"	"		"
			108	3.75-10.5	SM	"	"		"
			110	5.5-9.7	SM	"	"		"

120,000 yds TOTAL

APPENDIX V

DESIGN REPORT

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE - Soil Mechanics Laboratory

800 "J" Street, Lincoln, Nebraska 68508

SUBJECT: ENG 22-5, Virginia WP-08, Upper Blackwater Watershed, Site No. 4 (Franklin County) DATE: April 7, 1971

TO: Louis S. Button, Jr., State Conservation Engineer
SCS, Richmond, Virginia

ATTACHMENTS

1. Form SCS-354, Soil Mechanics Laboratory Data, 4 sheets.
2. Form SCS-128, Consolidation Test Data, 2 tests, 2 sheets.
3. Form SCS-355A & B, Triaxial Shear Test Data, 4 tests, 7 sheets.
4. Form SCS-352, Compaction and Penetration Resistance, 9 sheets.
5. Form SCS-357, Summary - Slope Stability Analysis, 3 sheets.
6. Form RTSC-FW-ENG-42, Determination of s and Probable Joint Gaps, 1 sheet
7. Investigational Plans and Profiles.

DISCUSSION

GENERAL

The proposed flood prevention dam is located in the Piedmont physiographic area. It is designated as a class "b" dam, has a maximum height of 47 feet, and it has a 1.88-square-mile drainage area.

FOUNDATION

A. Bedrock. The bedrock at the site is granite. It occurs at depths from about 4 feet to 12 feet on the abutments on centerline and at depths of about 7 to 9 feet outside the channel area in the floodplain section. The bedrock is exposed in the channel downstream from centerline.

Refer to the geology report for a description of the bedrock.

B. Soil Classification. The soil mantling the bedrock is logged as residual on the upper part of the abutments with colluvium on the lower right abutment and alluvium in the floodplain section. The sequence of these materials along with the field classifications is well outlined in the geology report, Form SCS-315 (copy attached).

Samples of the alluvium were submitted from the proposed principal spillway location, and the index test data obtained are recorded on the attached Form SCS-354. The samples submitted are classed as ML, CL, and GP-GM. The fine-grained samples contained from 58 to 72 percent fines, the LL's ranged from 27 to 34, and the PI's ranged from 4 to 13. The GP-GM contained 6 percent fines.

In addition to the samples from the principal spillway location, three samples of alluvium and one sample of colluvium were submitted from centerline test holes. The colluvium is a CL that contains 73 percent fines, the LL is 30, and the PI is 11. The samples of alluvium are classed as CL, ML, and SM.

C. Shear Strength. An undisturbed sample of the ML alluvium was submitted from test hole 311. This sample had a density of about 1.50 g/cc. A consolidated undrained triaxial shear test was made and the shear strength parameters obtained are $\phi = 16°$, c = 700 psf. These represent the saturated shear strength values. The test was made at natural moisture content, which was greater than 95 percent of theoretical saturation.

For design purposes we suggest shear strength parameters of $\phi = 35°$, c = 0 for the SM and GM materials.

D. Consolidation. The foundation materials are quite stratified and the individual stratum are quite thin; consequently, a consolidation test was not made on the core sample because of the limited thickness of material represented. Based on the amount of consolidation that occurred on the triaxial shear test specimens, we expect the consolidation potential of the foundation at the TP-6 location to be less than 0.5 foot.

E. Permeability. It is anticipated that the cutoff trench will extend through the alluvial and the colluvial material.

EMBANKMENT MATERIAL

A. Soil Classification. Samples of borrow material submitted are grouped and the index test data are summarized as follows:

Material	Sample No.		% Passing				LL	PI	Class	Proctor Density	
	Field	Lab.	0.002 mm.	0.005 mm.	#200	#4				Max. γ_d pcf	w_o %
CL colluvium and residual soil	4.1	71W-1094	28	39	73	100	30	11	CL	110.5	16.5
	203.1	1099	32	42	73	100	31	12	CL	105.0	17.5
	107.1	1103	39	48	81	100	38	15	CL	100.5	22.5
ML and SM alluvium and residual	11.1	1097	11	18	61	100	28	0	ML	102.0	18.5
	206.1	1100	10	14	54	100	34	0	ML	95.0	23.5
	101.1	1101	8	11	53	94	34	0	ML	109.5	18.5
	102.1	1102	7	9	39	100	N	P	SM	103.5	20.0
MH residual	202.1	1098	69	73	89	100	53	9	MH	87.0	31.5
GC-GM alluvium	110.1	1104	12	15	28	61	28	6	GC-GM	106.5	19.5

B. Shear Strength. Consolidated undrained triaxial shear tests were made on an ML (11-1), a CL (203-1), and an MH (202-1) to represent the range of fine-grained materials submitted. The tests were made at 95 percent of standard Proctor density. The test specimens were back-pressured to saturate them, and pore pressure was measured during shear. The data obtained are summarized as follows:

Sample No.	Class	Test γ_d pcf	B Parameter	Shear Strength Parameters			
				Total Stress		Effective Stress	
				ϕ deg.	c psf	$\bar{\phi}$ deg.	$\bar{c}$ psf
71W1097	ML	96.8-97.3	0.95-0.98	20.5	800	31.0	500
71W1098	MH	82.6-83.3	0.95-0.98	6.5	1200	11.0	1200
71W1099	CL	99.7-100.1	0.95-0.98	10.0	475	27.5	200

The test values are suggested for design.

C. Consolidation. Consolidation tests were made on the MH (71W1098) and on the CL (71W1099). The tests were made on specimens compacted to 95 percent of standard Proctor density. The test specimens were molded slightly wet of standard Proctor optimum using a kneading compaction technique. The data obtained are shown on the attached Forms SCS-128. The data indicate that the MH has a consolidation potential of about 4% and that the CL has a consolidation potential of about 6% for a loading equivalent to that in the base of the fill.

SLOPE STABILITY

The stability of the proposed embankment slopes was checked with a circle method of analysis using a computer and the SCS program, and with a sliding block method (Navdocks).

The lowest shear strength parameters were obtained on the CL, and for the analysis we considered that the interior section of the embankment would consist of this type of material with outer sections of the ML. Laboratory charts based on a circle method of analysis were used to determine that the total stress values for the CL and the effective stress values for the ML resulted in the least shear strength for the loading range planned, and they were used in both the computer and the sliding block methods of analysis.

The analysis shows that the proposed $2\frac{1}{2}$:1 downstream slope with the 10-foot berm planned at elevation 1272 has a factor of safety of 1.54 (trial No. 3) with the steady seepage condition considered.

The sliding block analysis on the upstream slope shows that the 3:1 slope planned below the 10-foot berm at elevation 1273.7 should be flattened to 4:1 to obtain a factor of safety greater than 1.35 for the full drawdown condition.

A summary of the analysis is attached.

CONCLUSIONS AND RECOMMENDATIONS

A. Cutoff. We concur with the proposal to bottom the cutoff trench in sound granite below sediment pool elevation. We suggest that the CL colluvial or residual soil be used for backfill in preference to either the MH or the ML. We recommend that it be placed at a minimum of 95 percent of standard Proctor density.

B. Principal Spillway. The proposed location crosses the ℄ of dam at Station 3+00. The bedrock surface undulates, and the thickness of alluvium ranges from about 4 feet to 9 feet. At the intersection of the centerline of the dam and the centerline of the principal spillway the alluvium is 7 feet thick. The consolidation potential at this point is judged to be less than 0.5 foot. Based on this estimate and considering a foundation thickness of 5 feet, the horizontal strain is estimated to be in the range of 0.006 ft/ft. Refer to the attached Form RTSC-FW-ENG-42 for the computation. A $\bar{\phi}$ angle of 30° is suggested for conduit loading computations.

C. Drain. A drain designed to control the phreatic line in the embankment and to intercept any seepage that might bypass the cutoff is suggested. We suggest that the point of control of the phreatic line be no further downstream than the c/b = 0.6 point. The filter limits should be designed in accordance with soil mechanics Note 1.

D. Embankment Design.

1. Placement of Material. We suggest that the MH and the CL like Sample 71W1099 be restricted to use in the interior section of the fill. We recommend a minimum placement density of 95 percent of standard Proctor density, and we suggest a placement moisture slightly wet of optimum.

2. Slopes. The test data and analyses indicate that the following slopes have acceptable factors of safety:

   a. Upstream. 2½:1 above a 10-foot berm at elevation 1273.7 and 4:1 below the berm.

   b. Downstream. 2½:1 with a 10-foot berm at elevation 1272 and with a drain to control the phreatic line.

3. Settlement. An overfill allowance of 1.25 feet is suggested to compensate for residual consolidation in the fill and foundation.

Louis S. Button, Jr.
Subj: Virginia WP-08, Upper Blackwater, Site No. 4

Prepared by:

Lorn P. Dunnigan
Head
Soil Mechanics Laboratory

Attachments

cc:
Louis S. Button (4)
Neil F. Bogner, Upper Darby, Pa. (2)

SOURCE AND USE OF MATERIALS	CLASSIFICATION	ADOPTED DESIGN DATA							REMARKS
		γ_d (pcf)	γ_m (pcf)	γ_{sat} (pcf)	γ_{sub} (pcf)	ϕ (deg.)	tan ϕ	c (psf)	
① EMBANKMENT	MH	82.9	109.0	115.5	53.0	6.5°	0.111	1200	
②						11.0°	0.194	1200	CU
③ EMBANKMENT	CL	99.9	117.5	137.5	75.0	10.6°	0.176	475	
④						27.5°	0.521	200	CU
⑤ EMBANKMENT	ML	97.2	115.0	123.0	60.5	20.5°	0.374	600	
⑥						31.0°	0.601	500	CU
⑦ FOUNDATION	ML	94.4	—	122.3	59.5	16.0°	0.287	700	
⑧									

TRIAL NO.	SLOPE	MAXIMUM SECTION CONDITIONS AT STATION 3+35	F_s
1 UP	2½:1	FULL DRAWDOWN, 10 FT. BERM AT ELEV. 1273.7, ARC THRU. ZONED EMB. [CORE	
	3:1	(10°-475), SHELL (31°-500)] PLUS 2 FT. FOUND. (16°-700) AND 2 FT. FOUND. (35°-0)	*1.32
1A UP	2½:1	SAME CONDITIONS AS TRIAL NO. 1, EXCEPT 4:1 SLOPE BELOW	
	4:1	BERM	1.51
2 UP	2½:1	FULL DRAWDOWN, 10 FT. BERM AT ELEV. 1273.7, ARC THRU. ZONED EMB.	
	4:1	[CORE (10°-475), SHELL (31°-500)] ONLY	1.51
3 DN	2½:1	DRAIN AT γ_b=0.6, 10 FT BERM AT ELEV. 1272.0, ARC THRU. ZONED EMB.	
		[CORE (10°-475), SHELL (31°-500)] AND 2 FT. FOUND (16°-700)	*1.54
4 DN	2½:1	DRAIN AT γ_b=0.6, 10 FT BERM AT ELEV. 1272.4, ARC THRU. ZONED EMB.	
		[CORE (10°-475), SHELL (31°-500)] ONLY	1.61
	*	WEAK ARC LOCATED IN ONE OF TWO FOUNDATION STRATA BY BORING LOG.	
		AND LAYERED FOUNDATION WITH RADIUS INCREMENTS OF 2 FT. BY	
		COMPUTER	
5 UP	2½:1	FULL DRAWDOWN, 10 FT. BERM AT ELEV. 1273.7, VILLAGE THRU. ZONED EMB.	
	4:1	[CORE (10°-475), SHELL (31°-500)] AND 2 FT. FOUND (16°-700)	1.60
5A UP	2½:1	SAME CONDITIONS AS TRIAL NO. 5, EXCEPT BLOCK SLIDING AT	
	4:1	TOP OF 2 FT. FOUND (35°-0)	1.39
6 UP	2½:1	SAME CONDITIONS AS TRIAL NO. 5, EXCEPT BLOCK SLIDING AT TOP	
	4:1	OF 2 FT. FOUND (35°-0)	1.50
7 DN	2½:1	DRAIN AT γ_b=0.6, 10 FT. BERM AT ELEV. 1272.0, VILLAGE THRU. ZONED EMB.	
		[CORE (10°-475) SHELL (31°-500)] AND 2 FT. FOUND (16°-700) BLOCK SLIDING AT	1.62

TOP OF 2 FT. FOUND. (35°-0)

MATERIALS TESTING REPORT

U.S. DEPARTMENT of AGRICULTURE
SOIL CONSERVATION SERVICE

SUMMARY - SLOPE STABILITY ANALYSIS

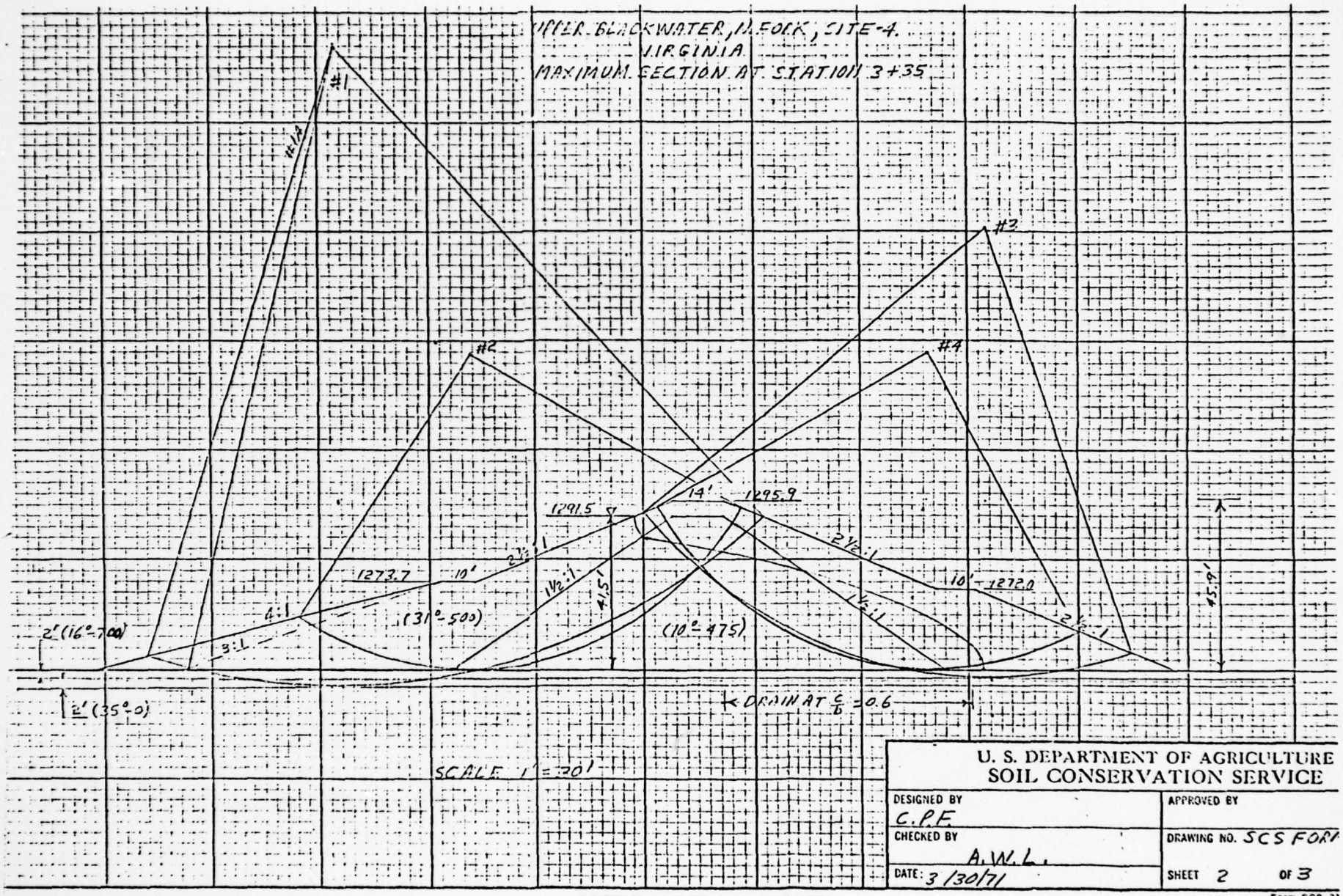
PROJECT and STATE: UPPER BLACKWATER, N. FORK, SITE 4, WEBSTER

METHOD OF ANALYSIS: SWEDISH CIRCLE AND BLOCK

ANALYZED AT: SALT LAKE CITY, UTAH

APPROVED BY

DATE: 3-31-71



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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CHECKED BY A.W.L.	DRAWING NO. SCS FORM
DATE: 3/30/71	SHEET 2 OF 3

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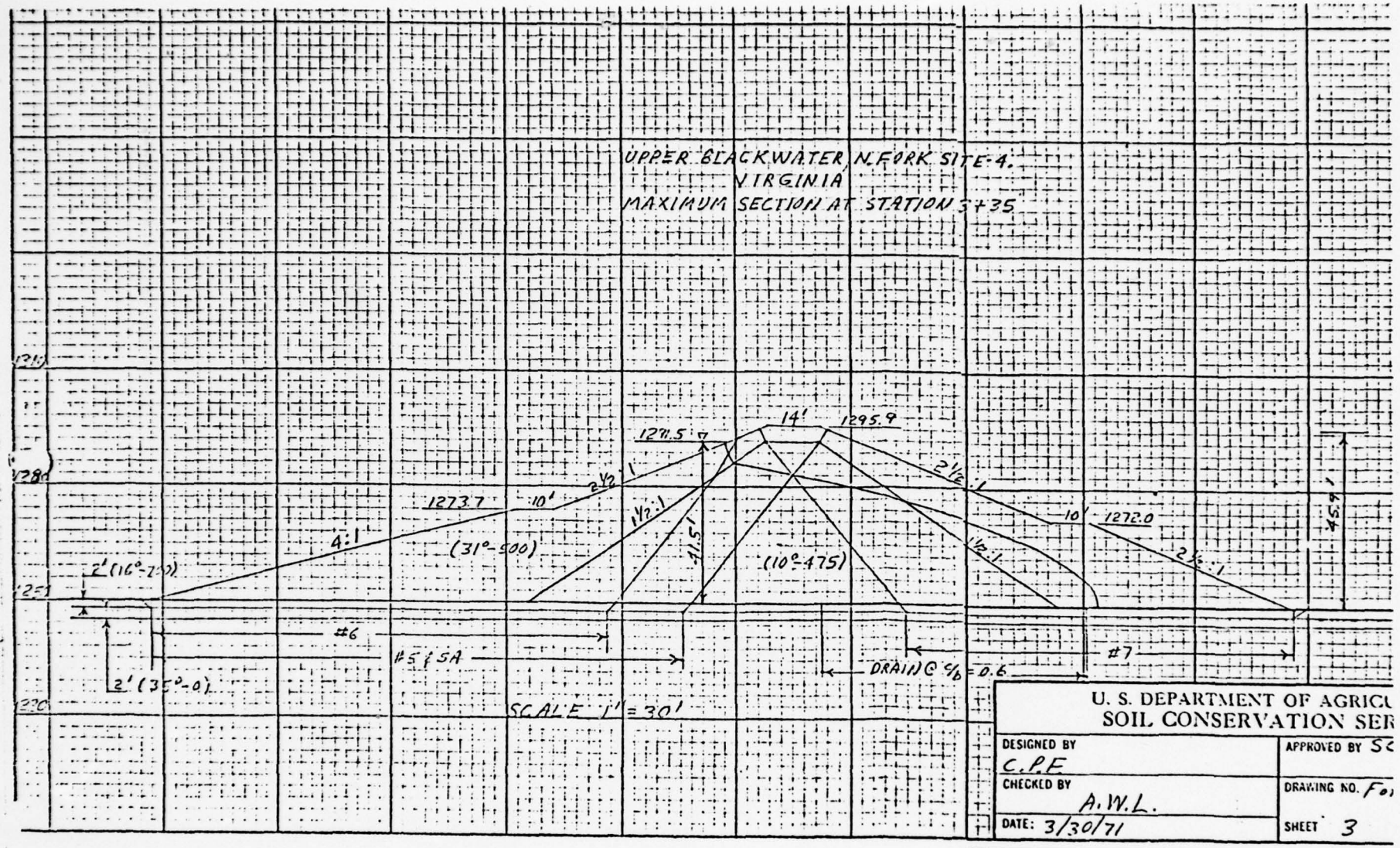
Form SCS-31

UPPER BLACKWATER, N. FORK SITE-4.
VIRGINIA
MAXIMUM SECTION AT STATION 3+35

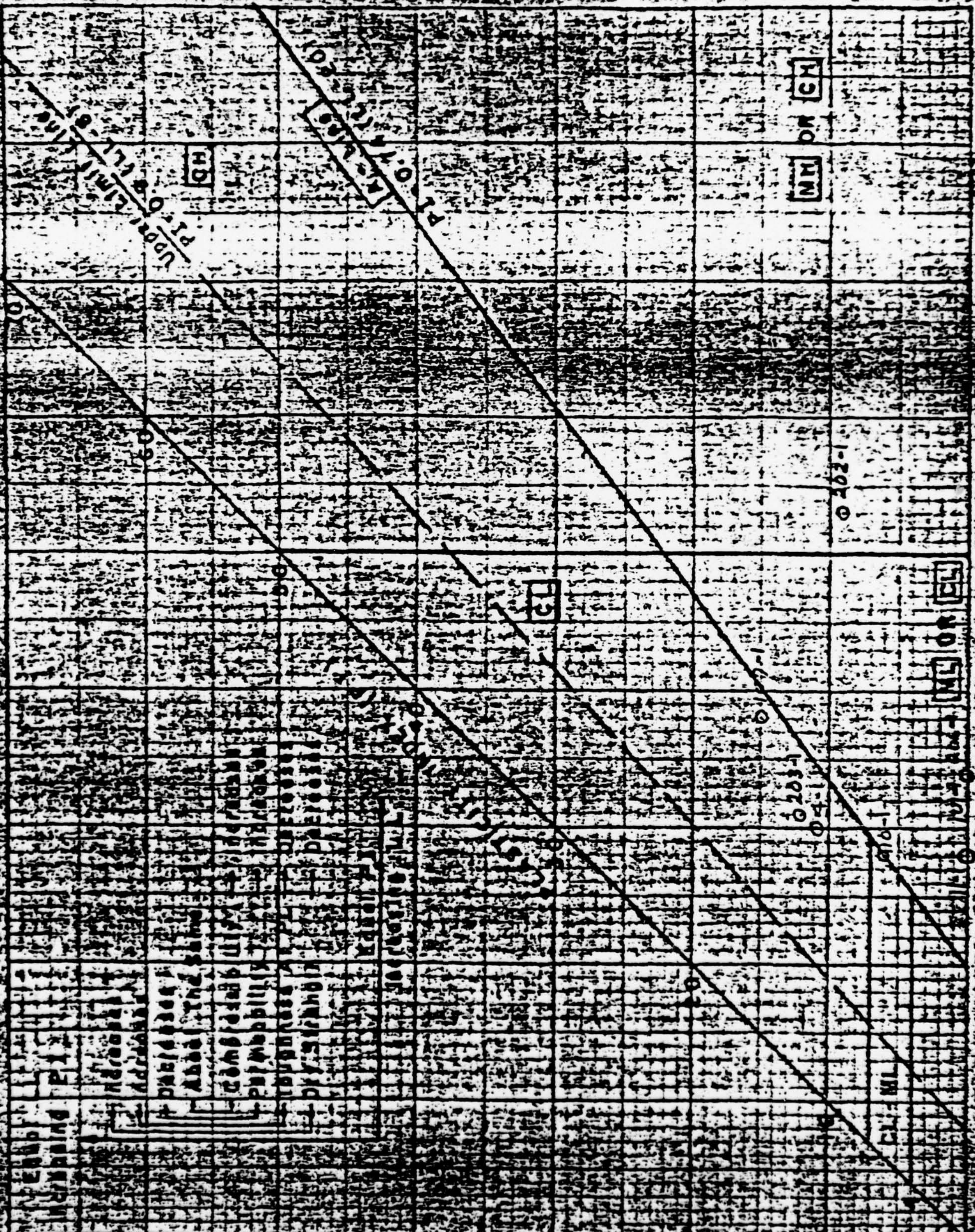


U. S. DEPARTMENT OF AGRICU
SOIL CONSERVATION SER

DESIGNED BY C.P.E	APPROVED BY SC
CHECKED BY A.W.L.	DRAWING NO. Fo
DATE: 3/30/71	SHEET 3

State: VIRGINIA		Project: UPPER BLACKWATER #4			
By: JFB	Date: 6/71	Checked By: RWC	Date: 10/71	Job No. VA-618-7	
Subject: PLASTICITY PLOT				Sheet 4 of 15	

EMBANKMENT MATERIALS



State: VIRGINIA — Project: UPPER BLACKWATER No. 1

By: JEB Date: 6/71 — Checked by: RWC Date: 10/71 — Job No.: VA-818

CLASSIFICATION OF EMBANKMENT MATERIALS

Sheet 5 of 12

SAMPLE	DEPTH	USCS	D [illegible] mm	[illegible]	LL	% .005 mm	PIPING *	CRACKING *	REMARKS
FOUNDATION MATERIAL									
6-1	15-48	CL	0.028	8	28	22	4	4	OK
101-1	10-40	SM	0.085	0	25	21	6	5	Check P&C
301-1	15-32	ML	0.041	0	30	22	4	5	Check C
302-1	30-43	GP-GM	3.20	—	—	2	3	4	OK
306-1	10-30	ML	0.034	7	30	29	4	5	Check C
310-1	10-20	CL	0.010	12	34	43	4	6	Check C
311-1	[illegible]	ML	0.026	4	27	21	6	5	Check P&C
ZONE 1 CORE MATERIAL									
4-1	10-67	CL	0.013	11	30	39	4	5	Check C
102-1	10-20	CL	0.006	15	38	48	2	4	OK
202-1	10-77	MH	0.005	19	53	73	1	1	OK
203-1	7.5-10.5	CL	0.010	12	31	42	4	2	OK
ZONE 2 SHELL MATERIAL									
1-1	3.5-5.0	ML	0.046	0	28	18	6	5	Check P&C
111-1	2.5-6.5	ML	0.060	0	34	11	6	5	Check P&C
102-1	6.0-11.0	SM	0.150	—	—	9	5	3	Check P
110-1	2.0-5.5	GC-GM	6.40	6	28	15	3	4	OK
206-1	6.0-11.0	ML	0.063	0	34	14	6	5	Check P&C

* DEGREE OF RESISTANCE (GREATEST TO LEAST)

STATE		PROJECT		
VIRGINIA		UPPER BLACKWATER #4		
BY	DATE	CHECKED BY	DATE	JOB NO.
JFB	6/71	RWC	10/71	VA-618-L
SUBJECT				SHEET 6 OF 15
STABILITY AGAINST PIPING				

CHECK THE POSSIBILITY OF ONE MATERIAL MOVING INTO ANOTHER BY THE FOLLOWING CRITERIA FROM NAVDOCKS DM-7, P. 7-

A. IF $C_u > 1.5$ THEN $\frac{D_{15F}}{D_{85B}} < 5$

IF $C_u < 1.5$ THEN $\frac{D_{15F}}{D_{85B}} \leq 6$

B. IF $C_u < 4$ THEN $\frac{D_{50F}}{D_{50B}} < 25$

C. IF $C_u < 4$ THEN $\frac{D_{15F}}{D_{15B}} < 20$

IF $C_u > 4$ THEN $\frac{D_{6F}}{D_{15B}} \leq 40$

	SAMPLE NO.	C_u	D_{15}	
FOUNDATION MATL.	6-1	>4	0.002	
	10-1	>4	0.002	
	301-1	>4	0.002	
	302-1	>4	0.30	Avg. 0.0445
	306-1	>4	0.002	
	310-1	>4	0.002	
	311-1	>4	0.002	
ZONE I MATL.	4-1	>4	0.002	
	107-1	>4	0.002	Avg. 0.002
	202-1	1	0.002	
	203-1	>4	0.002	
ZONE II MATL.	11-1	>4	0.0034	
	101-1	>4	0.0075	
	102-1	>4	0.011	Avg. 0.0064
	110-1	>4	0.0052	
	206-1	>4	0.005	

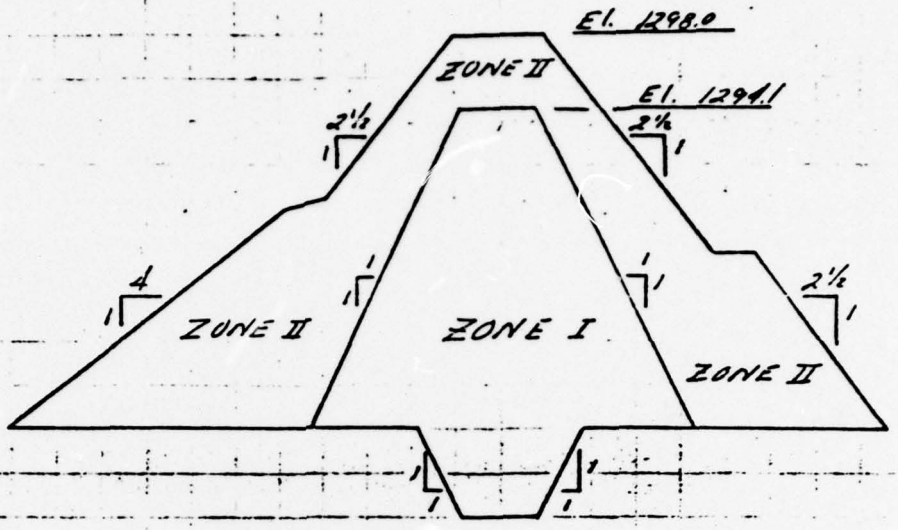
EMBANKMENT MATERIALS ARE STABLE AGAINST PIPING.

SCS-522 REV 5-58 SOIL CONSERVATION SERVICE

GPO 1958 O-471466

STATE	PROJECT		
VIRGINIA	UPPER BLACKWATER #4		
BY / DATE	CHECKED BY / DATE	JOB NO	
JFB 12/72		VA-618-E	

SUBJECT MATERIALS INVENTORY SHEET 7 OF 15



TYPICAL SECTION EMBANKMENT ZONING

1. THE FILL MATERIAL IS TO COME FROM THE EMERGENCY SPILLWAY EXCAVATION, AND THE BORROW AREAS LOCATED IN THE SEDIMENT POOL AREA. NO BORROW IS TO BE TAKEN WITHIN 100 ft. OF THE UPSTREAM EMBANKMENT TOE. A FILTER STRIP, MINIMUM OF 15 ft. FROM EITHER CHANNEL BANK, IS TO BE LEFT IN NATURAL VEGATION, EXCLUDED FROM BORROW.

2. ZONE I MATERIAL, APPROXIMATELY 30,000 Cu. Yds., COMES FROM THE EMS EXCAVATION AND BORROW AREA "A". THIS MATERIAL, P.I. FROM 9 to 15, IS REPRESENTED BY SAMPLES 202-1, 203-1, 107-1 & 4-1.

3. ZONE II MATERIALS, APPROXIMATELY 54,000 Cu. Yds., COMES FROM THE EMS EXCAVATION, AND BORROW AREAS A, B, C & D. THAT PORTION OF THIS MATERIAL HAVING BEEN TESTED, RANGES IN P.I. FROM 0 to 6, AND

MATERIALS INVENTORY IS REPRESENTED BY SAMPLES 11-1, 101-1, 102-1 & 206-1.

4. AS EMS EXCAVATION REACHES DEPTH OF ROCK, THE MATERIAL WILL BECOME UNSUITABLE FOR ZONE I FILL, THE ENGINEER WILL DIRECT FILL PLACEMENT OF THIS MATERIAL, ANY TO BE SPOILED, WILL BE HAULED & SPOILED IN DESIGNATED AREA. THE TOP LAYER OF CL MATERIAL IN THE BORROW AREAS WILL GO INTO ZONE I FILL, WHILE THE DEEPER GM & SM MATERIALS GO INTO ZONE II.

5. BORROW EXCAVATION NEEDS TO BE PLANED WITH THE REALIZATION THAT PORTIONS OF THE BORROW WILL BE SUBJECT TO FLOODING WHEN THE PRINCIPAL SPILLWAY BECOMES FUNCTIONABLE.

MATERIAL REQUIRED:

ZONE I, CORE:	30,100 Cu. Yds.
ZONE II, SHELL:	53,100 Cu. Yds.

MATERIAL AVAILABLE:

ZONE I:	
EMS CUT	
BORROW "A" @ 25'	25,000 Cu. Yds.
ZONE II:	5,750
EMS CUT	30,750 Cu. Yds.
BORROW "A" @ 10'	14,100 Cu. Yds.
BORROW "B" @ 55'	2,300
BORROW "C" @ 40'	20,750
BORROW "D" @ 40'	8,950
	6,350
	52,450 Cu. Yds.

EARTH FILL REQUIREMENTS

ZONE	MATERIAL	SOURCE	MAX. ROCK SIZE [1]	MAX. LIFT [2] THICKNESS	REQUIRED WATER CONTENT	COMPACTION [3] CLASS	COMPACTION [3] DEFINITION
					(OPT.)		
1	4-1 CL	BORROW A	6"	9"	16.5	A	95% MAX. ϒd ASTM D-698 METHOD A
1	107-1 CL	BORROW A	6"	9"	22.5	A	
1	202-1 MH	EMS	6"	9"	31.5	A	
1	203-1 CL	EMS	6"	9"	17.5	A	
2	11-1 ML	BORROW B	6"	9"	18.5	A	
2	102-1 SM	BORROW B	6'	9"	20.0	A	
2	110-1 GC-GM	BORROW B	6"	9"	19.5	A	
2	206-1 ML	EMS	6'	9"	23.5	A	

[1] FOR FILL ADJACENT TO STRUCTURES, MAX. ROCK SIZE = 3"
[2] AT TIME OF PLACEMENT
[3] FOR TYPICAL COMPACTION CURVES SEE Sht 18 of plans

DF-EBF-8
N-3 (Jan. 67)

By JFB Date 7/71 Checked By Date 10/71 Job No. 44-618-5
Subject: EARTH FILL REQUIREMENTS Sheet 84 of 15
KINGMAN UPPER BLACKWATER #4

VIRGINIA		UPPER BLACKWATER #4		
By JFB	Date 6/71	Checked BWR	Date 10/71	Job No. VA-618-E

Subject CUTOFF TRENCH BOTTOM WIDTHS Sheet 9 of 15

CRITERIA:

(1) $w = \frac{h_1 - d}{2}$ (2) $w = h_2 - d$ (3) $w \geq 12'$

h_1 = Difference in elevation between emergency spillway and stripped ground at centerline of cutoff trench.

h_2 = Difference in elevation between permanent pool and stripped ground at centerline of cutoff trench.

d = Depth of cutoff trench excavation

w = Bottom width of cutoff trench

Station	d	h_1	h_2	w (1)	w (2)
5+95	0	0	0	—	—
5+50	4.5	9.7	0	2.6	—
4+50	5.0	35.1	23.4	15.05	18.4
3+50	6.0	42.5	30.8	18.25	24.8
2+50	10.5	37.7	26.0	13.6	15.5
1+50	12.0	24.3	12.6	6.15	0.6
0+50	15.5	2.7	—	—	—
0+10	0	0	0	—	—

Summary:

Use uniform bottom width of 12', located on ℄ Dam. From EMS Crest to Non-rippable rock in foundation.

DF-E&F-7

With a near positive cutoff to granite and apparently solid foundation materials, little seepage is expected through the embankment or foundation. Therefore no seepage analysis will be preformed, and in conformance with the Soils Lab recommendations a trench drain will be installed to intercept any subsequent movement of water through the embankment or foundation, and to insure a dry downstream embankment toe.

This drainage system will vary in depth, being taken to bedrock or the GM-GP layer in the foundation. The drain will extend to the 100 yr. sediment pool elevation on either abutment and incorporate a 6" perforated drain pipe in conjunction with the filter materials.

The filter material will be checked for any piping potential with respect to the adjacent foundation materials, zone I & II materials, and the 5/16" preforations in the drain pipe.

An outlet for the drainage system will be designed along the E principal spillway, emptying into the plunge pool.

PIPING POTENTIAL

Assuming fine concrete aggregate to be used as the filter element, test piping potential of: Case 1, adjacent foundation materials; Case 2, Zone I core material; and Case 3, Zone II shell material.

SOIL CONSERVATION SERVICE

STATE		PROJECT		
VIRGINIA		UPPER BLACKWATER #4		
BY	DATE	CHECKED BY	DATE	JOB NO.
JFB	6/71	RWC	10/71	VA-618-E
SUBJECT				SHEET 12 OF 13
EMBANKMENT DRAIN				

PIPING POTENTIAL

Case 1 - Adjacent foundation materials

Sample No.	P.I.	D_{85} Base	D_{15} Filter
10-1	0	0.30	0.2
301-1	7	0.25	0.2
302-1	0	65.00	0.2
310-1	13	0.17	0.2
311-1	4	0.28	0.2

Criteria: for $P.I. \leq 7$, D_{15} filter $\leq 4 \times D_{85}$ base
for $7 < P.I. \leq 15$, D_{15} filter $\leq 5 \times D_{85}$ base

Criteria met; Piping Not a problem.

Case 2 - Zone 1 materials

Sample No.	P.I.	D_{85} Base	D_{15} Filter
4-1	11	0.17	0.2
107-1	15	0.06	0.2
202-1	9	0.04	0.2
203-1	12	0.08	0.2

Criteria: for $7 < P.I. \leq 15$, D_{15} filter $\leq 5 \times D_{85}$ base

Criteria met, Piping not a problem.

Case 3 - Zone 2 materials

Sample No.	P.I.	D_{85} Base	D_{15} Filter
11-1	0		0.2
101-1	0		0.2
102-1	0		0.2
110-1	6		0.2
206-1	0		0.2

"Use a dual element drain with fine concrete aggregate as fine filter material, and coarse concrete aggregate as coarse filter material." This is to prevent the fine element from entering the pipe perforations, and gives added capacity.

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U S DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

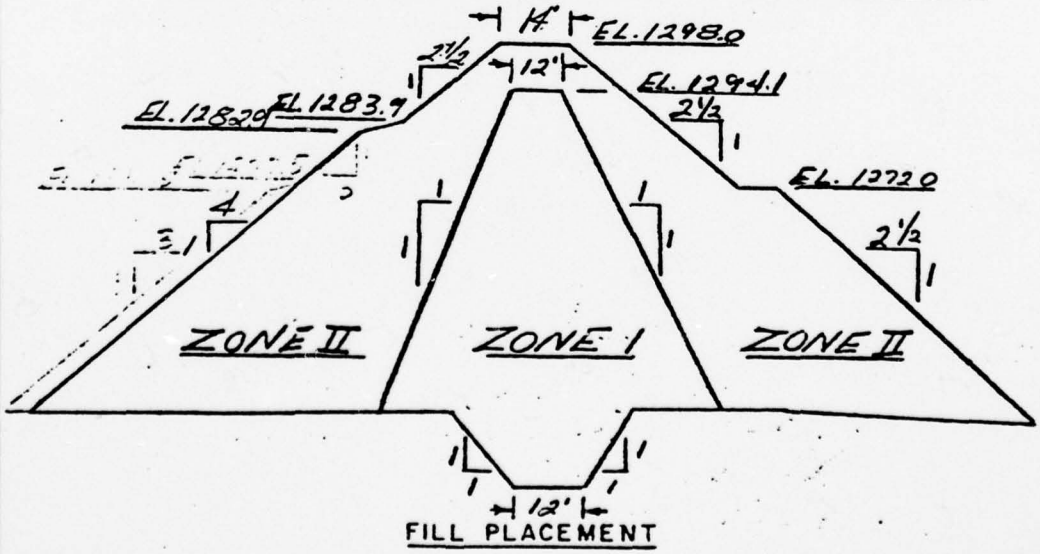
DESIGN REPORT SUMMARY

I. Watershed Data
- A. Structure Class 6
- B. Drainage Area ..... 4.203 Ac.
- C. Time of Concentration - T_c ..... 2.84 Hrs.
- D. Hydrologic Curve Number - C_n
  - 1. Moisture Condition II 59.5

II. Principal Spillway
- A. Conduit
  - 1. Inside Dia. ..... 24 In.
  - 2. Length ..... 320 Ft
- B. Riser
  - 1. Inside Dimensions ..... 2.0 x 6.0 Ft.
  - 2. Height (Floor to Crest) ..... 30.0 Ft.
- C. Weir Length ..... 12 Ft.
- D. Orifice Dimensions ..... 18 x 18 In.
- E. Reservoir Drain Size ..... 24 In.
- F. Type of Energy Dissipater ..... Riprap Plunge Pool

III. Emergency Spillway
- A. Width ..... 100 Ft.
- B. Side Slopes 3:1
- C. Length of Level Section ..... 30 Ft.
- D. Exit Slope ..... 0.04 Ft./Ft.
- E. Max. Velocity in Exit Section @ D.H.W. ..... 4.76 Ft./Sec.
- F. Duration of Flow thru Emer. Spillway @ D.H.W. ..... 5.75 Hrs.
- G. Frequency of Use 1%

IV. Earth Fill
- A. Height ..... 19.2 Ft.
- B. Volume ..... 100,600 C.Y.
- C. Compaction ..... Class A



FILL PLACEMENT

Sht. 4

APPENDIX VI

REFERENCES

1. Recommended Guidelines for Safety Inspection of Dams, Office of the Chief of Engineers, Department of the Army, Washington, D.C.

2. HEC-1DB Flood Hydrograph Package (Hydrologic Engineering Center, U.S. Army Corps of Engineers, September 1978).

3. "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian", Hydrometeorological Report No. 33, (U.S. Weather Bureau, April 1956).